FORTY-FIFTH ANNUAL REPORT

OF THE

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

1922

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OF THE

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

CONDUCTED JOINTLY BY THE

NORTH CAROLINA DEPARTMENT OF AGRICULTURE

AND THE

NORTH CAROLINA STATE COLLEGE OF AGRICULTURE AND ENGINEERING

Fiscal Year Ending June 30, 1922
Statistical Report Year Ending December 1, 1922

LETTER OF SUBMITTAL

RALEIGH, N. C., June 30, 1922.

To His Excellency, CAMERON MORRISON,

Governor of North Carolina.

SIR:—I have the honor to submit herewith report of the operations of the Agricultural Experiment Station, conducted jointly by the North Carolina Department of Agriculture and the North Carolina State College of Agriculture and Engineering, for the year ended June 30, 1922. This work is under the immediate direction of the "Joint Committee for Agricultural Work," provided for in chapter 68 of the Public Laws of 1913, and amended by chapter 223 of the Public Laws of 1917, and the report is made in accordance with the requirements of the act of Congress, approved March 2, 1887, and known as the Hatch Act.

Very respectfully,

B. W. Kilgore.

Director.

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*A. T. McCallum	Hot Springs
*C. C. Wright	Hunting Creek
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*J. F. Diggs	Rockingham
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STAFF OF THE NORTH CAROLINA EXPERIMENT STATION AND EXTENSION SERVICE

B. W. Kilgore	Director, Experiment Station and Extension Service
C. B. Williams	Vice-Director, Experiment Station
F. E. Miller	Assistant Director, Branch Stations
J. M. Gray	Assistant Director Extension
F. H. Jeter	Agricultural Editor
A. F. Bowen	Bursar
Miss Mary H. McKimmon	Bursar
Miss Mary S. Birdsong	Secretary to the Director
H. C. Evans	Auditor and Executive Assistant

AGRONOMY

C. B. Williams	Chief Division of Agronomy
W. F. Pate	Soil Agronomist
E. C. Blair	Extension Agronomist
R. Y. Winters	Agronomist in Plant Breeding
S. K. Jackson	Assistant in Plant Breeding
G. M. Garren	Assistant in Plant Breeding
S. W. Hill	Assistant in Plant Breeding
L. G. Willis	Soil Chemist
†W. E. Hearn	Soil Survey
†S. O. Perkins	Soil Survey

CHEMISTRY

W. G. Haywood	Fertilizer Chemist
E. S. Dewar	Assistant Chemist
F. W. Sherwood	Assistant Chemist
B. Naiman	Assistant Chemist
L. M. Nixon	Assistant Chemist
B. C. Williams	Assistant Chemist
Z. B. Bradford	Assistant Chemist
C. L. Williams	Assistant Chemist

ENTOMOLOGY

Franklin Sherman	Chief, Division of Entomology
Z. P. Metcalf	Entomologist
R. W. Leiby	Assistant Entomologist
C. S. Brimley	Assistant Entomologist
T. B. Mitchell	Assistant Entomologist
W. B. Mabee	Extension Entomologist
C. L. Sams	Specialist in Beekeeping

HORTICULTURE

C. D. Matthews	Chief, Division of Horticulture
J. P. Pillsbury	Horticulturist
L. H. Nelson	Assistant Horticulturist
E. D. Bowditch	Assistant Horticulturist
F. E. McCall	Garden Specialist
R. F. Payne	Extension Horticulturist
C. L. Williams	Research Assistant Horticulturist

*Members of Joint Committee for Agricultural Work.

Officers and Staff

ANIMAL INDUSTRY

R. S. Curtis	Acting Chief, Animal Industry Division
Earl Hostetler	Beef Cattle and Swine
F. T. Peden	Beef Cattle and Swine
†George Evans	Sheep Extension
W. W. Shay	Swine Extension
J. W. Watts	Assistant in Swine Extension
B. F. Kaupp	Poultry Pathologist
A. G. Oliver	Poultry Extension
E. G. Wardin	Assistant in Poultry Extension
Stanley Combs	Dairy Experimentalist
J. A. Arey	Dairy Farming
†F. R. Farnham	Assistant Dairy Farming
A. C. Kimrey	Assistant Dairy Farming
†H. S. Wilson	Assistant Dairy Farming
J. O. Halverson	Feed Chemist and Specialist in Nutrition

PLANT PATHOLOGY

F. A. Wolf	Plant Pathologist
S. G. Lehman	Assistant Plant Pathologist
G. W. Fant	Extension Pathologist

DRAINAGE

F. O. Bartel	Drainage Engineer

MARKETS AND RURAL ORGANIZATION

B. F. Brown	Chief, Division of Markets
Gorrell Shumaker	Marketing Fruits and Vegetables
R. O. Moen	Credit Unions
J. M. Workman	Warehouse Construction
†P. H. Hart	Cotton Grading
J. I. Johnson	Assistant in Cotton Grading
†J. P. Brown	Warehouse Inspection and Operation
V. W. Lewis	Livestock Marketing
†Frank Parker	Agricultural Statistician
W. M. Rhodes, Jr.	Assistant Agricultural Statistician

BRANCH STATIONS

R. E. Currin, Jr.	Assistant Director Edgecombe Branch Station
F. T. Meacham	Assistant Director Piedmont Branch Station
S. C. Clapp	Assistant Director Mountain Branch Station
Charles Dearing	Assistant Director Coastal Plain Branch Station
E. G. Moss	Assistant Director Tobacco Branch Station
J. L. Rea, Jr.	Assistant Director Blackland Branch Station

FARM FORESTRY

†H. M. Curran	Farm Forestry Specialist

FARM ENGINEERING

E. R. Raney	Specialist in Farm Engineering

FARM DEMONSTRATION

C. R. Hudson	State Agent
S. J. Kirby	Assistant State Agent
E. S. Millsaps	District Agent, Piedmont District
C. C. Proffitt	District Agent, Mountain District
T. D. McLean	District Agent, Central District
O. F. McCrary	District Agent, Northeastern District
E. W. Gaither	District Agent, Southeastern District

HOME DEMONSTRATION

Mrs. Jane S. McKimmon	State Home Demonstration Agent
Miss Maude E. Wallace	Assistant State Home Demonstration Agent
Mrs. Estelle T. Smith	Eastern District Agent
Mrs. Cornelia C. Morris	Central District Agent
Miss Martha Creighton	Piedmont District Agent
Miss Pauline Smith	Tidewater District Agent

†In co-operation with United States Department of Agriculture.

FORTY-FIFTH ANNUAL REPORT

OF THE

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

For the Year Ended June 30, 1922

B. W. Kilgore, *Director*
F. E. Miller, *Assistant Director Branch Stations*
F. H. Jeter, *Agricultural Editor*

The true title of this report should be, "Why North Carolina is Fifth in Value of Farm Crops." The Agricultural Experiment Station and the Agricultural Extension Service of the State College of Agriculture and the State Department of Agriculture are so closely related in North Carolina that it is easy to take the results of investigations directly to the farmer through the extension organization. The farmers, on the other hand, have freely used the service proffered them and through the year, because of their close association, there has been built a more solid and substantial agriculture in the State.

This past year has been one of service to the State by all the workers of the two organizations. The year has seen the organization of the two great coöperative marketing associations, and while the investigational workers did not devote such a large part of their time to this work, they did give such aid as the limited time at their disposal permitted, and there is no doubt but that the careful investigations previously made pointed the way to this successful undertaking by North Carolina farmers. The year 1922, therefore, marks an epoch in the farm life of North Carolina.

It marks an epoch also in that the farming population of the State began its recovery from the after-effects of the Great War and in spite of local hardships at various points, in spite of some few cases of marking time, on the whole the State is going forward in a progressive, wholesome way that is to be commended and admired.

The Experiment Station undertakes to solve the fundamental facts about good farming. It wants to prove by actual tests the right way or the wrong way to handle a farm problem, and after the solution has been determined by long continued studies under all conditions, it is passed on to the extension group to be transmitted in turn to the men and women actually engaged in farming. It can be seen from the following pages that the Experiment Station has tried to concern

itself with the big, outstanding problems of farming in the State. Some of the projects have been completed and the results have been issued in printed form or otherwise given into the hands of the farm folks. There are many problems that must be studied for years and a number of investigations are continued year after year with reports being printed from time to time and with the project remaining as a subject of study in order that the farmer may be correctly informed each year. Other problems there are which are of interest purely to those of a scientific mind and which furnish material for other investigators to make of practical benefit to the farmer. In this latter class, the Station also takes high rank, as some of its investigators have contributed scientific papers to the best scientific journals and publications of the day, and lectures before the leading scientific organizations.

The agricultural press and the general press have carried many articles giving reports on the work of the Station and in this way the Station is also trying to render service.

CHANGES IN STAFF

Changes in staff since the last report include the following: Resignations: W. W. Magill, Assistant Horticulturist; Fred R. Yoder, Specialist in Rural Credits; J. M. Dyer, Assistant Horticulturist; Miss Mamie Sue Jones, Tidewater District Agent in Home Demonstration Work; J. E. Ivey, Assistant in Poultry Investigations; A. S. Cline, Assistant Director, Blackland Branch Station; H. H. B. Mask, Assistant State Agent in Farm Demonstration work; and R. W. Green, Editor.

Appointments: E. D. Bowditch, Assistant Horticulturist; F. E. McCall, Garden Specialist; R. F. Payne, Extension Horticulturist; E. G. Wardin, Assistant in Poultry Extension; G. W. Fant, Extension Pathologist; J. L. Rea, Jr., Assistant Director Blackland Branch Station; H. M. Curran, Farm Forestry Specialist; S. J. Kirby, Assistant State Agent in Farm Demonstration work; Miss Pauline Smith, Tidewater District Agent in Home Demonstration work; F. H. Jeter, Editor; L. G. Willis, Soil Chemist, and R. O. Moen, Specialist in Credit Unions.

PUBLICATIONS

Publications issued during the past year are as follows:

Bulletins:

Number 243—*Winter and Summer Fattening of Steers in North Carolina.*
By R. S. Curtis, F. T. Peden and F. W. Farley.

Number 244—*Methods and Cost of Raising Pigs to the Weaning Age.*
By Dan T. Gray and Earl Hostetler.

Number 245—*Rural Organization.*
By Carl C. Zimmerman and Carl C. Taylor.

Technical Bulletins:

Number 20—*Studies on the Physiology of Some Plant Pathogenic Bacteria.*
By FREDERICK A. WOLF, L. V. SHUNK, AND A. C FOSTER.

Number 21—*The Gloomy Scale.*
By Z. P. METCALF.

Annual Report:

Forty-fourth Annual Report for the Year Ending June 30, 1921.
By Director B. W. KILGORE.

These publications are sent to the mailing list of the Station, which now numbers about 7,562 names divided into small lists under subject matter heads. Approximately 11,000 copies of the publications issued have been mailed to this list.

In addition to the above publications, a number of bulletins have been issued by Experiment Station workers and published by the State Department of Agriculture. These bulletins are reported in the Annual Report of the Commissioner of Agriculture.

AGRONOMY

As in previous reports, the Agronomy Division maintains that the soil survey is the basis of the intelligent planning and carrying on of work in soil fertility, crop adaptation, crop rotation, and the fertilization of crops. Despite the fact that there was a temporary reduction in the field force, the division has surveyed about 900,000 acres during the past year. Cumberland and Haywood counties have been finished, about one-half of Sampson has been worked, and the Currituck-Camden area is now being surveyed.

The division conducts fertility investigations on all of the branch station farms, as well as the central station farm located at the college near Raleigh. General deductions made from these fertility investigations show that on the mountain soils phosphoric acid, nitrogen, and lime are the main controlling plant food factors in crop growth. Organic matter added to the soils will also increase the average yields. Acid phosphate has proven to be the most efficient carrier of phosphoric acid with general field crops, legumes and grasses, though basic slag is also showing up as an efficient source of this element. Soybeans for annual growth and red clover of the longer growing varieties fit in well with the crop rotation adapted to this section.

On the Piedmont soils phosphoric acid and nitrogen must first be supplied for profitable crop growth. Potash is not so essential. It has been shown also that there is a greater need for longer crop rotations in which legumes are included and that organic matter is very necessary on the heavy soils. Lime is beneficial where legumes

are grown; acid phosphate is the most economical carrier of phosphoric acid; nitrate of soda and sulphate of ammonia are the best carriers of nitrogen of the inorganic compounds, and cottonseed meal is one of the best carriers of nitrogen of the organic compounds. Orchard grass, red top, and red clover should be included in the pasture mixtures.

On the Coastal Plain soils results show that nitrogen and potash are first needed for the most profitable crop production. Lime and organic matter are also beneficial on these soils and increase the efficiency of fertilizers. Acid phosphate is the best carrier of phosphoric acid; nitrate of soda and sulphate of ammonia are the most efficient carriers of nitrogen. Results show also that larger amounts of fertilizers than are generally used can be used with profit under cotton on these soils.

For the muck and peat soils of eastern North Carolina, lime is the first essential for a profitable crop. This is true, however, only after proper drainage has been secured. Experiments show that about two tons of ground limestone per acre broadcast over three years is the correct amount to apply. Burnt lime is about as good as limestone and both give better results than marl. Planting and cultivating on the ridge give better crop yields than disking shallow and planting flat. On account of the general destruction of crop diseases in this territory, there is a great need for better crop rotations.

In soil chemistry, L. G. Willis was appointed during the year to succeed Dr. J. K. Plummer and is now beginning a study of two problems. His first problem will be to study the effect of different soil treatments on the availability of potash in the common soil forming minerals. The results are expected to show whether or not the petrographic analysis of a soil can be relied upon to indicate the needs of the soil for potash. Another problem will be to determine the cause of unsatisfactory crop yields on the muck soils.

In experiments with tobacco, dolomitic limestone applied at the rate of one ton per acre across one end of each of the 36 fertilizer plots show that there is less leaf-spot trouble on the limed end than on the unlimed section. The limestone does not depreciate the value of tobacco. The division, therefore, recommends the use of dolomitic limestone where the content of magnesium carbonate runs as high as 25 per cent. On the 20 plots where special potash work is being conducted, results show that from 36 to 40 pounds of actual potash is about the right quantity to use on the type of soil mapped as the Durham sandy loam. Muriate of potash gives increased yields over sulphate, though the burning quality of the tobacco so produced is not so good as where the sulphate is used. On the 18 plots where the different carriers of magnesium and potash are studied, results show

that dolomitic limestone will control the disease known as "sand-drown" and that both the yield and quality is improved. Where calcite was applied, both sand-drown and leaf-spot were serious except where double manure salts and kainit were used as the source of potash. On those plots where no limestone was applied, both sand-drown and leaf-spot were serious except where double manure salts and kainit were applied, and the yield of tobacco was from 35 to 40 per cent less than on the other series. Breeding work and selections in improving existing varieties of tobacco are still being carried on, and satisfactory results are beginning to appear. Rotations are also being worked out which are proving to give better yields and to improve the quality of tobacco grown in this rotation. Experiments in which tobacco follows cowpeas or soybeans to provide nitrogen show that a crop of tobacco of average quality can be produced without the application of nitrogen in a commercial form. However, this is not recommended indiscriminately because of the fact that some growers will produce tobacco of poor quality. It has also been definitely proven that a permanent seedbed can be established at a convenient location to the farm home, provided the seedbed is thoroughly sterilized from year to year with live steam. A seedbed of this kind when once established will grow healthy, strong plants.

In crop improvement work the study of association and inheritance of economic qualities in cotton has been continued and much data has been secured for publication. The division is carrying on a "place effect" study of cotton in coöperation with the Mississippi Experiment Station.

At the Central Station Farm the division has made a number of studies with new crops, with different seed selections and a number of cultural tests. Some interesting facts have been developed about many of these new crops and indications are that some of them will be adapted to North Carolina conditions. Of the new strains of cotton grown for the first time, the variety known as Delfos from the Mississippi station gave the best results last year. Seed improvement work includes plant-to-the-row, and increase plots of cotton, corn, soybeans, wheat, rye, and sorghum. All of the cotton breeding work is being done on the strain of Mexican big boll variety. This strain is rapidly gaining favor in North Carolina on account of its large yield and extra length of staple. In plant-to-row tests a number of the rows furnished staple 1⅛ inches long and have been unusually productive.

Breeding work with corn is being continued with strains of Cocke's Prolific. Unusual success has attended the work of the division in the improvement of soybeans. Three pedigree strains of Virginia, three of Haberlandt and eight of Mammoth Yellow soybeans have been increased and compared with the original varieties from which they came. The best strain of these varieties have been distributed

to branch station farms and to private growers over the State, where they are meeting with unusual success.

In cotton spacing tests it is shown that the unthinned plots continue to give the highest yields and in the other plots thicker spacing has also yielded best. At each of the branch station farms an effort is being made to improve those crops best adapted to that particular section, and so far excellent results are being secured. This is done in the case of the Edgecombe Branch Station, where about 200 bushels of highly improved cotton seed were sold in 1921 and 1,200 bushels are offered for sale from the 1922 crop.

ANIMAL INDUSTRY

In this division the work of animal nutrition is receiving close attention. Hogs are being fed various kinds of feeds to determine the effect of oily feeds on the bodies in producing soft pork. The division has also studied the nutritive value of the peanut and its results and effects. It has been known for some time that better livestock is produced in the limeststone regions, and for that reason the effect of calcium in commercial feeds is also receiving attention. The division has found that there is no fishy flavor detected in the resulting pork from feeding fish meal. Feeding hogs with various amounts of oily feeds such as peanuts indicate that this oil is the chief factor in making soft pork. A number of other tests are being made to determine the effects of different feeds on the carcasses of pigs, using 12 pigs on peanuts, 12 on soybeans, and making shipments of three pigs to the Bureau of Animal Industry at intervals of four weeks each, beginning with the close of the grazing period. During the past year approximately $100 was won by the hogs bred and owned by the Experiment Station.

At the Edgecombe Branch Station it was found that it costs $4.07 to raise a pig to the weaning age. It was found also that hogs grazing on about $^{7}/_{10}$ of an acre of peanuts will make an average daily gain of about $^{8}/_{10}$ pound, at the cost of $11.40 per hundred pounds of gain. These hogs may be finished at a cost of $7.70 per hundred pounds of gain, using shell corn, tankage, and peanuts. At the Blackland Branch Station it was found that corn can be marketed through hogs for $1.10 per bushel instead of 65 cents, the prevailing price of corn when the experiment was begun. At the Piedmont Branch Station it cost $3.97 to raise a pig to the weaning age. On this farm also it was shown that pigs made over a half-pound average daily gain on soybean pastures.

With dairy cattle, the division is seeking to determine the effect of cottonseed meal on cows and heifers in reproduction. Some interesting results have been secured from the heavy feeding of cotton-

seed meal, and the results show that this is not advisable. At the Coastal Plain Station the division is seeking to develop a herd of registered Jerseys. At the present time there are 53 registered Jerseys on this farm, consisting of 23 cows in milk, which are producing an average of above 300 pounds of butterfat during a year. Four years ago only two cows of the herd had ever produced as much as 300 pounds of fat in one year, and this was done only once. The operating expenses of the dairy are being taken care of by the cash receipts. The increase in value of the herd and the manure have been sources of profit.

Excellent results have been secured during the year in the study of poultry. A number of scientific articles have been prepared by the division and a great mass of correspondence has been carried on in answer to letters of inquiry. It has been found that the normal temperature of the adult is about 107.4 degrees F. and that at night the temperature will fall to 105 degrees. This knowledge has been of value in the study of fowl typhoid, in which the temperature rises as high as 114.5 degrees F., or 7 degrees of fever.

A curve showing the rate of growth of single-comb White Leghorns has been established from their period of hatching to 34 weeks of age. The average size fowl weighing 8 or 9 pounds will breathe normally about 20 times a minute. A hen of this same breed will breathe about 35 times a minute. It is not profitable to give a constant fourteen-hour feeding period to laying hens by the use of lights, as the second year shows a decrease in egg production. After the first of April the extra light should be lessened. A fowl may go 365 days without replenishing its grit, as shown by the fact that two hens were in perfect health and good flesh at the end of this period during which no grit had been given.

Extra facilities have been added to the division for carrying on investigational work at the Mountain Branch Station and at the Coastal Plain Station.

In feeding cottonseed meal to beef animals in reproduction, results show, as in the case of the dairy animals, that excess amounts of this feed cause abortion, weak calves, and soft bones. The milk produced from the cows receiving such ration fails to produce normal growth with calves. When the meal has been fed to ewes in moderation, there is no bad effect. Experiments show also that stomach worms can be eliminated from sheep by the use of copper sulphate. Good results have attended the feeding tests of cattle in western North Carolina, and the work shows conclusively that beef cattle can be produced profitably in that section.

ENTOMOLOGY

Potato spraying and flea-beetle control work at the Mountain Branch Experiment Station shows that a gain of 57 bushels of potatoes per acre over unsprayed plot was secured on the plot treated with home-made poison Bordeaux mixture. In boll weevil work, studies made show that the migration of 1922 completes the invasion of the entire cotton growing territory of North Carolina with the exception of Currituck County. Two species of boll weevil parasite have been reared, one of which is known to have killed 13 per cent of the weevils in one field. Experiments in dusting with calcium arsenate show a return of $25 worth of cotton per acre resulting from dusting treatment costing $5.00 per acre.

Field tests conducted in the sandhill section of North Carolina show that 38 per cent of the fruit on peach trees were wormy when not sprayed, while an adjacent plot that had been carefully treated showed only 6 per cent of the harvested fruit to be wormy.

The Division of Entomology is carrying along definite projects in the study of pecan insects, the larger corn stalk borer, spraying of potatoes, the use of laundry soap in water for aphids, insect survey of North Carolina, black corn weevil, dusting cabbage and collards, green clover worm, control of mosquitoes, cut-worms, household insects, peach borer, canker worm, parasites of the Hessian Fly, and the bean-leaf beetle. This bean-leaf beetle is an insect pest of the first magnitude that was first established around Birmingham, Alabama, in 1919. It has since spread rapidly and in 1921 invaded the North Carolina counties in the southwestern part of the State. Indications are that it will be another serious pest affecting North Carolina agriculture.

The work in using laundry soap in water to control aphids has been completed, and it was found that one pound of laundry soap to four gallons of water will give good results. During the year, November, 1921, to November, 1922, 235 species have been added to the list of insects being secured by the division, and the total has now been brought up to 6,344. Experiments in the dusting of cabbage and collards to control worms show that the pest may be controlled by dusting every ten days with a mixture at the rate of one pound of lead arsenate to six pounds of air-slaked lime, dusting while the plants are moist. Experiments to control peach borer by the use of paradichlorobenzine indicate that five-year-old trees will withstand an application of three-fourths of an ounce of this material without injury and that a high per cent. of the borers will be killed by the gas given off. Some results have been secured in determining a safe date for planting corn to escape the attack of corn root worm. Other experiments have been made to determine whether a soil repellent can be secured to use against this pest.

HORTICULTURE

Due to the fact that there have been a number of changes in the workers of this division, considerable effort has been given to a more thorough organization of the work during the past year. The division has attempted to develop a program of horticultural work that will contain live projects definitely adapted to the basic and special problems of North Carolina. Experimental work is being conducted with apples, peaches, pecans, sweet potatoes and Irish potatoes. A number of projects were discontinued temporarily for lack of funds.

The training and pruning experiments with apples at the Mountain Station has been one of the outstanding pieces of work done by the division last year. The results indicate that the growers have been pruning the apple trees too severely, causing a reduction in the production of fruit. Studies of pecan varieties have proved the value of the Schley, Stuart, Alley, and Success varieties for Eastern North Carolina. Additional proof has also been secured of the value of the Coastal Plain region for successful pecan production. It was found that it is necessary to cultivate pecans during dry weather.

Work with Irish potatoes has proven the value of the rural New Yorker group for production and storage in Western North Carolina. An important phase of work in developing seed potatoes in Western North Carolina for planting in Eastern North Carolina is being continued vigorously and indicates that a large seed potato industry can be developed in the western part of the State to prove of mutual advantage to both sections. The division is making a study of the natural fruits of North Carolina, and paintings and photographs are being made of the important varieties.

In peach breeding work, about sixty varieties of peaches were planted at the Coastal Plain Station and an effort is being made to improve commercial varieties grown, suited to North Carolina conditions. Twenty varieties of peaches were planted at the Mountain Station to determine the relative hardiness of these peach varieties in that section. About 32 varieties of pecans are being studied to determine the best varieties to use in this State. A study is also being made of the individual trees so as to improve the standard yields by bud selection.

In vegetable culture about 29 varieties of sweet potatoes are being studied to determine the most desirable varieties for Eastern North Carolina, keeping in mind the production, marketing value, keeping qualities, and food qualities of the varieties under consideration. Considerable work is also being done in studying storage methods. Variety tests of Irish potatoes, using 20 different varieties, are being conducted in Western North Carolina. The observation garden at the Coastal Plain Branch Station continues to give valuable data as to

the different varieties and best planting dates for vegetables in Eastern North Carolina.

Genetic studies with bramble fruits, especially raspberries, show that good wild stock can be secured so as to carry on the work of crossing varieties at the station farm. Twenty-six combinations in crossing rotundifolia grapes with other species were made in 1921, and 49 combinations during the past year. This year 30 seedlings, representing eight special species combinations, have been grown to size for transplanting. The research work being attempted on the Central Station farm is being carried along satisfactorily with good progress being made in nearly all projects.

PLANT PATHOLOGY

In plant pathology it has been found that the organism causing tobacco wilt will also attack a number of other crop plants, like Irish potatoes, tomatoes, and egg-plants, as well as a number of common weeds. The rust resistant varieties of wheat tested in coöperation with the Division of Agronomy are not suited to North Carolina. The bacterial leaf blight of the soybean has been found to be distinct from other bacterial diseases of clover which have been studied in the laboratory and greenhouses.

A number of scientific articles have been prepared by this division for the various scientific journals during the past year, and of much local interest was the one about Indian Tuckahoes, which are underground structures known since the early settlement of America, but remaining a botanical mystery until this investigation was made. This paper was published in the Journal of Elisha Mitchell Society and created considerable interest throughout the State.

MARKETS AND RURAL ORGANIZATION

The year 1922 was a great year for encouragement of coöperative marketing in North Carolina. It saw the formation of the cotton and tobacco marketing associations and the continued growth of coöperative marketing in a smaller way among the individual farmers of the State. Having in charge the State Warehouse System, the Division of Markets reports that this system has grown from 32 warehouses last year with an aggregate capacity of 49,050 bales of cotton, to 78 warehouses having a total capacity of 212,620 bales of cotton. All cotton in these warehouses is insured by the State Warehouse Superintendent and is carried in such a manner as to effect a large saving to the growers.

There has been little demand for the classing of cotton during 1922 because of the organization of the coöperative cotton marketing association. The division has operated only two grading offices out-

side of Raleigh, in which about 12,000 bales of cotton have been classed. The division is now coöperating with the cotton association in carrying on classing work, and at present there are eight classers and five helpers engaged in this work. The division also assisted in the construction of two warehouses with an aggregate capacity of 10,000 bales. A survey was made of 300 towns as marketing and storage centers for cotton. Plans have been drawn and warehouses constructed at four other points in the State, and when finished these warehouses will have a total capacity of 26,000 bales. A number of places have been visited during the year in the interest of improving the warehouse facilities for cotton.

With livestock there has been great activity in the coöperative marketing of hogs for farmers. During the year about 13 counties produced and sold coöperatively about 33 cars of hogs, fed under the direction of the Office of Swine Extension and sold through the division. A great deal of this work has been done in the cotton growing section and has been largely a boll weevil measure. The division has found that there are certain times during the year when hogs bring a higher price, and is encouraging farmers to take advantage of this market condition.

With lambs, the market has been much better during the past year and farmers have been encouraged to sell their lambs on local markets when they received from 15c to 20c per pound gross weight, and to make coöperative shipments later when the price is less. The wool pool conducted by the division last year was thoroughly successful; over 300 growers consigned nearly 45,000 pounds of wool for which they received an average price of 30c per pound.

Some work has also been done in the coöperative sale of cattle, and one sale at Spruce Pine where 300 head of cattle were sold gave very satisfactory returns to the farmers taking part. An effort is being made by the division to create a good market for cheese in North Carolina and adjoining states. The coöperative factories in the western part of the State are now producing around 400,000 pounds of cheese per year. One other important project during the past year was the carrying on of the farm fencing campaign to encourage the building of pastures for growth of livestock.

With fruits and vegetables the greatest activity during the year has been with sweet potato growers. Several local associations have been welded into a State Federation, which had for sale 70,000 bushels of potatoes last year. All the legal forms used by this federation were prepared by the division.

With the assistance of the farm and home agents, a number of curb and city market stalls have been organized and established for

the coöperative selling of farm produce. The division has continued its work in the standardization of grades, in getting out news about market prices, and in furnishing agricultural statistics to the people of the State. The crop reporting service has done excellent work during the past year in furnishing economic data and interpretations about farming, and this work is now showing the most complete results of any period of its existence. In making the farm census, the division has had reports from 85,000 farm tracts. Each report covers 34 basic items of information.

During the year Mr. R. O. Moen has been secured as specialist in credit unions and an effort is now being made to put these organizations on a sound financial footing.

FARM DRAINAGE

The Farm Drainage Division has continued its services in assisting in the improvement of land now under cultivation by the use of proper drainage and terracing methods. It has also helped in the establishment of drainage districts in order to make other land fit for cultivation.

The division has assisted in teaching club boys over the State how to locate terraces, holding several schools for this purpose. During the past twelve months 44 farms in 22 counties were visited for the purpose of studying tile drainage. The area of the tracts covered by this survey and for which plans and reports were prepared covers a total of 1,016 acres on 16 farms. Over 88,000 feet of tile, reaching about 17 miles, have been put in on 13 farms in nine counties. About 22,000 feet of open ditch was staked out for construction during the year.

In terracing, 61 farms in 17 counties were assisted in preventing loss of soil by hillside erosion and about 28 miles of terraces were laid out. The division reports that the past year has been outstanding on account of the great interest taken and the work accomplished in tile drainage. In fact, it is the best record yet made by the division in this line of work.

DIVISION REPORTS

More complete information as to the work of the Station will be found in the reports by divisions, which follow the financial report.

FINANCIAL REPORT

THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION,
In Account With the UNITED STATES APPROPRIATION, 1921-1922.

Dr.

	Hatch Fund	*Adams Fund*
To receipts from the Treasurer of the United States, as per appropriations for the fiscal year ended June, 30, 1922, under Acts of Congress approved March 2, 1887 (Hatch Fund), and March 16, 1906 (Adams Fund)	$15,000.00	$15,000.00

Cr.

Salaries	$ 9,096.33	$15,000.00
Labor	4,012.65	
Postage and stationery	240.72	
Freight and express	223.48	
Seeds, plants and sundry supplies	289.99	
Fertilizers	392.30	
Feeding stuffs	736.07	
Buildings and land	8.46	
Total	$15,000.00	$15,000.00

THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION,
In Account With FARM AND MISCELLANEOUS RECEIPTS.

Dr.

To balance on hand	$ 920.49
Receipts from other sources than the United States for the year ending June 30, 1922	7,417.87
Total	$8,338.36

SUPPLEMENTAL STATEMENT

Cr.

Labor	$ 25.00
Publications	91.22
Postage and stationery	12.58
Freight and express	16.63
Heat, light, water and power	467.62
Chemicals and laboratory supplies	120.90
Seeds, plants, and sundry supplies	31.25
Feeding stuffs	24.54
Library	123.09
Tools, machinery, and appliances	231.45
Furniture and fixtures	44.25
Scientific apparatus and specimens	296.26
Traveling expenses	303.00
Contingent expenses	5,916.67
Buildings and land	633.90
Total	$8,339.36

We, the undersigned, duly appointed auditors of the corporation, do hereby certify that we have examined the books and accounts of the North Carolina Experiment Station for the fiscal year ending June 30, 1922; that we have found the same well kept and classified as above, and that the receipts for the year from the Treasury of the United States are shown to have been $30,000, and the corresponding disbursements $30,000, for all of which proper vouchers are on file, and have been by us examined and found correct, thus leaving nothing.

And we further certify that the expenditures have been solely for the purposes set forth in the Acts of Congress, approved March 2, 1887, and March 16, 1906.

(Signed) T. T. BALLENGER,
J. F. DIGGS,
Auditors.

(SEAL)

Attest: A. F. BOWEN, *Custodian.*

REPORT OF THE DIVISION OF AGRONOMY

To the Director:—During the year the work of the Division of Agronomy has gone forward mainly along the same lines mentioned in our last report. In the latter part of the year we secured the services of L. G. Williams to fill the position of Soil Chemist left vacant by Dr. Plummer. We expect this addition to our force to be of immense help in our soil investigational work and fertility studies. The work in the main has been conducted along the general lines indicated below:

SOIL SURVEY

During the year, the soil survey work has been carried on actively by the Division in coöperation with the Federal Bureau of Soils. Since the last report, Cumberland and Haywood counties have been finished, about one-half of Sampson has been worked, and work in the Currituck-Camden area has been started. The areas finished during the year embrace approximately 900,000 acres.

As stated in previous reports, anyone at all familiar with agricultural work must realize that a soil survey properly conducted is of the most fundamental importance to the intelligent planning and conducting of work in soil fertility, crop adaptation, crop rotation and the fertilization of crops. During the past few years there has been a steadily growing demand for the reports and maps of the survey of the different counties of the State. Not only have farmers shown interest in these, but rural school teachers, prospective settlers, lumbermen, highway engineers, secretaries of chambers of commerce, and others.

The survey has suffered during the year a temporary reduction in its force. It is hoped that it will soon be possible to increase the force back to at least its original number.

SOIL FERTILITY

Soil fertility investigations are being made by the Division of Agronomy at the following experimental farms:

Central Station Farm at Raleigh
Mountain Branch Station Farm at Swannanoa
Piedmont Branch Station Farm at Statesville
Blackland Branch Station Farm at Wenona
Coastal Plain Branch Station Farm at Willard
Tobacco Branch Station Farm at Oxford.

At Mountain Branch Station Farm

Field A.—An experiment is being conducted on Field A to determine the correct amount of nitrogen, phosphoric acid, potash and lime to apply on the crops grown in a rotation of corn, wheat and red clover. This experiment is being continued and the results so far secured indicate that phosphoric acid, nitrogen and lime are all needed to produce large crops, with phosphoric acid the first plant-food requirement. Lime used on red clover gives large gains, and when the clover is turned into the soil it furnishes a part of the nitrogen needed for larger crop yields.

Field D.—The experiment on this field is designed to show the relative value of acid phosphate and finely ground rock phosphate as carriers of phosphoric acid for crops grown on the Mountain Valley soils when used alone, with cover crops, and with manure. In this experiment, the rotation of crops consists of corn, oats, wheat and red clover. The results so far show that acid phosphate is a more economical carrier of phosphoric acid than is rock phosphate used on this soil. The fact is borne out when the two carriers are used with nitrogen and potash, with stable manure, and with legumes turned into the soil.

Field D (Continuous Corn with Crimson Clover and Phosphates).—In this experiment, corn is grown every year and crimson clover is sown each fall and turned under in the spring. The experiment is designed to show the relative value of acid phosphate and rock phosphate used under corn when a cover crop is turned under each year. Also, if sufficient nitrogen from the air can be secured by the legumes in the rotation to maintain large crops of corn. The results so far indicate that acid phosphate is the most efficient carrier of phosphoric acid when compared with rock phosphate. This holds true until the amount of rock phosphate used is about four times that of acid phosphate. Under the latter conditions, the rock phosphate treated plats are giving somewhat larger yields of corn. The experiment has been running now eleven years and the residual effect of the phosphates are beginning to show up.

Field F.—On this field the experiment is being conducted to study the best fertilizer to use in a rotation consisting of Irish potatoes, corn, wheat and red clover. Different amounts of nitrogen, phosphoric acid and potash are used in order to determine the best fertilizer formulas. Also muriate of potash, sulphate of potash and kainit were used comparatively as sources of potash.

The different sources of potash have not materially differently influenced the yield of Irish potatoes. The normal fertilizer used for potatoes was 800 pounds of an 8-4-6. This amount seems to pay better than when the different plant-food materials were increased in

amount. The use of lime is showing up to advantage with the red clover.

Field B (Rotation).—This field is planned and used to study the effect of growing crops continuously, in a two-year rotation and a three-year rotation with fertilizer. One end of this field has been limed to study the effect of liming with the different crop rotations. Continuous corn has shown to be nearly as good as when a rotation of corn and wheat is used; but the yield of wheat was nearly twice as good with the two-year rotation. Legumes in the two-year rotation have given increased yields of both corn and wheat. With a three-year rotation, when red clover was used, the yield of both corn and wheat was greatly increased. The uses of lime and phosphates have increased materially the yield of all the crops.

Field G.—This experiment is being made to compare phosphoric materials with a complete fertilizer, with limestone, and with stable manure. The results so far secured indicate that limestone and manure with fertilizers give better results than when fertilizer is used alone. Acid phosphate has proven better than rock phosphate, except when large quantities of the latter are applied. Basic slag is showing up fine, especially on the unlimed plants.

At Piedmont Branch Station Farm

Fields A, B, and C.—Fields A, B, and C of this farm are used to determine the most profitable formulas and right amount of fertilizers to be used with each crop, with and without lime, with a rotation of crops consisting of cotton, corn, wheat and red clover. In this experiment, acid phosphate, rock phosphate and basic slag are compared as carriers of phosphoric acid, used with and without manure. In these regular fertilizer experiments the results are quite conclusive in showing that phosphoric acid, nitrogen and lime in some available form are essential for larger and more profitable crop yields. It has been found that up to a certain limit, increasing the amounts of the plant-food materials has given increased yields. From observations made while doing Extension work, it was found that farmers are not using enough of any of these materials for best results. Increasing the amounts of potash has not, however, generally resulted in much gain in yield.

Field D (Rotation).—This experiment is designed to work out the same general results for the Cecil clay soil as is indicated as being done for the Toxaway soil of Field D at the Buncombe farm.

In a comparison continuous cropping and the same crops in a two-year rotation have given about the same results. When legumes are used in the two-year rotation, better results are secured; and when the rotation is broadened and red clover is used for one year

out of three, increased yields are the result. With the addition of limestone, the legumes make a much more satisfactory growth.

Field F (Different Nitrogenous Materials).—This experiment was started to compare some commonly used nitrogenous materials that are being used by fertilizer companies in making different fertilizer mixtures. In studying different carriers of nitrogenous materials under cotton and corn, the efficiency of the materials tried, when measured by crop yields, have been as follows: First, nitrate of soda; second, nitrate of ammonia; third, sulphate of ammonia; fourth, cottonseed meal; fifth, calcium cyanamid; and sixth, sewage sludge. These results are in accord with other results secured during a long period of years.

Field G.—This experiment is designed to show the relative value for the soils of this farm of acid phosphate and different amounts of rock phosphate; beginning with 500 pounds of rock phosphate to the acre once in every three years and going up as high as 3,000 pounds per acre once in every three years. The crops used on this field are corn, wheat and red clover.

In comparing acid phosphate with rock phosphate in different amounts, acid phosphate has given greater efficiency, except when 3,600 and 4,000 pounds of rock phosphate per acre were used every three years broadcast. From these results, it is believed that if farmers wish to use rock phosphate, it should be applied in large quantities at stated intervals in order to furnish enough available phosphoric acid to the crops the first year.

Field K (Soft Phosphate).—This field is used to study the comparative value for increasing crop yields of acid phosphate and soft phosphate rock used on corn, cotton and wheat. Studying the results with acid phosphate and soft rock phosphate with corn, cotton and wheat, they are very positively in favor of acid phosphate. When the amount of soft rock phosphate was doubled the yields were not increased.

It has been noted by the superintendent of the Iredell farm the marked improvement of the texture of the soils of the experimental plat to which lime has been added, as is evidenced by the portion washing less and plowing better than where no lime has been added.

Logan Field.—This field is used to study the comparative value of burnt lime, hydrated lime, and ground limestone used in amounts varying from one, two, to three tons per acre, applied every four years in a rotation consisting of velvet beans, rye, cotton, cowpeas, oats, vetch, red clover and crimson clover. In this test, acid phosphate is added in sufficient amounts for larger crops and the rotation is designed to furnish enough nitrogen for large crops.

The results from this field are inconclusive at the present time, especially as to the right amount and form of lime to use. So far, with the rotations used, enough nitrogen has been gathered by the

legumes grown in the rotations to supply the non-leguminous crops with nitrogen to make very good yields. It is hoped that this experiment will show the value of long rotations, including the legumes, and in cutting down of fertilizer bills.

At Edgecombe Branch Station Farm

This year, the only experiment carried on at this farm was a continuation of the Rotation Experiment (Field D), designed similarly to the one being conducted at the Piedmont and Mountain farms.

The main fertilizer experiments were discontinued during the year. These have in the past shown the need of the soil for nitrogen and potash for larger crop yields. Still larger gains were made when nitrogen and potash applications were increased two and three times the normal amounts. The use of phosphoric acid has shown good results, especially when moderately good applications of nitrogen and potash have been made. Lime has shown to good advantage and can be recommended for use in any good crop rotation scheme. From the results, it is evident that farmers might use, especially for cotton, larger quantities of fertilizer per acre. They might increase the amount from 400 to 500 pounds to 700 or 800, or more per acre for best paying results, when cotton is selling at a reasonable price.

From the results on Field D, the practice of growing either cotton or corn continuously in the same field is to be discouraged.

When summer or winter legumes are used in rotation with cotton and corn crops, yields have been increased some and when a three-year rotation is used, even greater yields are secured. It will be possible, it appears, by the use of legumes in a longer rotation, to cut down fertilizer bills to some extent.

At Coastal Plain Branch Station Farm

Field A.—This field is being used for an experiment to work out the best fertilizer formulas to use for cotton, corn, oats, and vetch in a three-year rotation in which summer or winter legumes are used every year. One-half of this field is limed once every three years, to study the relative effects of *lime* against *no lime* on the growing of legumes for building up the productiveness of the soil and on the efficiency of the different fertilizer treatments.

The results so far secured indicate the value of the use of more nitrogen and acid phosphate on this soil for both cotton and corn than is commonly used. When nitrogen was added in large quantities, larger crops were secured. The use of lime has given very good results and its use broadcast every three or four years with a rotation, including oats and vetch and soybeans, is recommended.

Field B.—In this experiment, a study is being made of the relative efficiency of different carriers of phosphate with and without lime. The rotation is the same as is being used on Field A. Acid phosphate has shown greater efficiency than either phosphate rock, soft phosphate or basic slag on this type of soil, as measured by the increase in crop yields from a unit application of phosphoric acid.

Field E.—This is an experiment which is designed to determine the plant food deficiencies of the soils occurring in that section of the State. Results show that this type of soil is in need of nitrogen and potash for greater crop yields. When both of these are used, phosphoric acid aids in making larger yields of crops. The use of lime has been found to give good results with leguminous crops.

The attention of visiting farmers has been called to the decidedly good effects of the use of lime, the disastrous effects of using no fertilizer and the poor economy of using heavy applications of fertilizers without the use of lime and the growing and turning under of organic matter.

At Blackland Branch Station Farm

Field A.—The experiment at this farm consists of a study of different fertilizer applications for corn, oats and Irish potatoes. No fertilizer combination used has given any practical increase in crop yields, while the use of lime gave a decided increase. Thus far, corn has been the only crop grown successfully. The field has now been divided across the plats into three one-acre plats which will be used for corn; for oats and soybeans; for Irish potatoes every year. Only one year's results have been secured from the residual effects of fertilizers and lime previously added to the different plats.

Lime Field.—In this experiment, burnt lime, marl and ground limestone are compared, using one, two, three and four tons per acre of each. Fertilizer is used on plats with the different amounts of ground limestone to determine if fertilizer will pay on this soil. The results thus far secured show that between two and three tons of lime are needed on these peat soils for the best results with corn when the lime is applied once every three years. A complete fertilizer with limestone has not given any crop increase over the use of ground limestone alone used at the rate of one, two, three and four tons per acre broadcast. Marl has not given as good returns as either hydrated lime or ground limestone.

Cultural Experiments.—In this experiment, different crops are used with the land disked four inches; plowed eight inches and rolled; and plowed twelve inches and ridged. Results so far secured indicate that ridge culture and disking four inches deep are best for corn and soybeans on this kind of soil. With small grain crops, rolling seems

to be an advantage. Stable manure has given good results, but causes crab-grass to grow and gives a lot of trouble.

Grass Plats.—This experiment consists of fifteen plats with the different mixtures of grasses that were thought to be of value for pasturage and hay in that section of the State.

Miscellaneous Experiments

To study the effect of cowpeas on the yield of crops, an experiment is being conducted on Alamance Silt Loam in Anson County. The cowpeas are being grown and turned under with and without lime. This experiment was started to check up the prevailing local opinion that the yield of crops was decreased when a crop of cowpeas is turned previously into the land. The plowing under of cowpeas on this type of soil has been found to give beneficial results, which is contrary to local opinion where these soils occur, but it is in harmony with the idea that organic matter from cowpeas is beneficial in the soil to future crops.

In the study of the use of gypsum on peanuts on the farm of B. B. Everett, Palmyra, it was found last year that where this material was applied to peanuts it gave an increase in the crop yield of more than enough to pay for the material and the expense of making the application.

In a study made of the plant-food needs of Ruston sandy loam soil in Cumberland County, in coöperation with the Federal Bureau of Plant Industry, it was found that all plant food ingredients are needed for best results with cotton. The results, too, indicate that best returns come from the use of about 900 pounds per acre of a fertilizer analyzing about 8 to 10 per cent phosphoric acid, 5 per cent ammonia and 4 per cent potash.

In coöperation with the Bureau of Plant Industry, some coöperative work, too has been carried on on the Georgeville sandy loam type of soil in Randolph County. The results thus far indicate very strongly that phosphoric acid and nitrogen are at present the main limiting plant-food factors for large crop yields. Potash used alone seems to give about the same or less than no fertilizer treatment. This is in accordance with previous results on heavy soils of the Piedmont section of the State.

Results from coöperative fertilizer work with the Bureau on cotton in Craven County on the Portsmouth sandy loam type of soil have shown that the use of phosphoric acid and nitrogen gave best results. Potash has shown some gains after phosphoric acid and ammonia are applied. Under cotton boll weevil conditions, it is advised for soils in average condition to increase the phosphates in fertilizer mix-

tures for cotton on these soils to at least 12 per cent, and use with it about 5 per cent ammonia and 3 per cent potash.

In the fertilizer experiment at Wilkinson on Portsmouth fine sandy loam soil, an application of fertilizer has not shown very much increase over the untreated plats. With cotton, basic slag and finely ground rock phosphate have given some increase in yields. Phosphates alone have not given very much increase over the no-treatment plats.

New Soil Experiments

New experiments have been started in cotton-variety fertilizer studies on Norfolk sandy loam near Whiteville; and on Portsmouth fine sandy loam near Edenton; also fertilizer experiments to determine the best fertilizer formulas for cotton grown on Norfolk sandy loam at Salemburg; on Marlboro fine sandy loam at Roseboro; and on Norfolk sandy loam at Speed.

A study of effect of potash on the yield of corn and cotton grown on Alamance silt loam has been started at Monroe.

Some General Deductions from Field Soil Fertility Investigations

For Mountain Soils.—It has been found that phosphoric acid, nitrogen and lime are the main controlling plant-food factors in the growth of more profitable crops on mountain soils. This includes both bottom and uplands. Organic matter incorporated in these soils has been found to increase crop yields materially.

Acid phosphate is the most efficient carrier of phosphoric acid with general field crops; with legumes and grasses, basic slag has been found also to be an efficient source of phosphoric acid.

In any scheme of crop rotation adopted, there should be included both annual and perennial legumes. Soybeans for the annual and red clover for the longer growing periods, fit in and do well in this section of the State.

For Piedmont Soils.—Phosphoric acid and nitrogen have to be supplied for the most profitable growth of crops on these soils. Potash is not nearly so essential. Longer crop rotations than are usually used, including more legumes, are needed. Organic matter is very essential for most of the heavy soils of this section. Lime is very beneficial especially when legumes are grown. Acid phosphate is the most economical carrier of phosphoric acid; and nitrate of soda and sulphate of ammonia are the best and most efficient carriers of nitrogen. Cottonseed meal is one of the best carriers of nitrogen in the organic class. In any pasture mixture of grasses, orchard, redtop and red clover should be used for best results.

For Coastal Plain Soils.—Our results are conclusive in showing the need generally with most soils of this section of nitrogen and potash for larger and more profitable crop production. Lime and organic matter are very beneficial on these soils and greatly increase the efficiency of fertilizers applied to the crops. Acid phosphate gives better returns than do other carriers of phosphoric acid tried out. Nitrate of soda and sulphate of ammonia stand out as the most efficient carriers of nitrogen. Cottonseed meal is one of the best organic carriers of nitrogen for Coastal Plain soils. On an average, larger amounts of fertilizers could be used with profit for cotton on these soils than is usually used, provided the right kinds are used and the crop is properly cultivated.

For Muck and Peat Soils.—Lime is very essential for profitable crop production on these soils, after proper drainage has been established. Two tons of ground limestone broadcast to the acre every three years seems to be about the correct amount to apply. Burnt lime is about as good as limestone, and both have been found to give better results than has the use of marl. This may be partially explained by the fact that the marl applied was much coarser than the other liming materials applied. Native grasses are choked out by crab grass when stable manure is applied to these soils. Planting and cultivating on a ridge have given crop increases over what was secured by disking shallow and planting flat. Better crop rotations should be established in this section of the State than is generally being used on account of the destructiveness of crop diseases and insects.

Publications

A bulletin on "The Results of Fertilizer Experiments with Corn on Mountain Soils" has been submitted for publication. Bulletins on the "Relative Efficiency of Different Nitrogenous Materials Used on North Carolina Soils," "Value of Lime on Peaty Soils," and "Results of Fertilizer Experiments with Wheat Grown on Piedmont Soils" will soon be ready for the printer.

Field Work in Soil Survey

There were found 40 different types of soil in Cumberland County; 17 in Cherokee; and 8 in Haywood. Typical samples were taken for chemical analyses of all these types, including the subsoil. Cumberland has both Piedmont and Coastal Plain soils, which accounts for the large number of soil types found in that county.

Over sixty per cent of the soil area of the State has now been surveyed, and it seems very desirable that the whole area of the State should be finished in the next few years.

SOIL CHEMISTRY

After remaining vacant for several years, L. G. Willis has been appointed to fill the position of Soil Chemist, succeeding Dr. Plummer. In carrying out the soil fertility investigations, it is necessary for the Soil Chemist to work out many problems in order to reinforce and interpret the field results on crops and fertilizers.

Two problems are now being started as follows:

A study will be made of the effect of different soil treatments on the availabilty of the potash in the common soil forming minerals. This will comprise pot culture tests with muscovite and biotite micas and feldspar; orthoclase and microcline, the common soil forming potash minerals of the State, using rye and wheat as winter crops and soybeans and cowpeas as summer crops. The influence of the fineness of division of the minerals on the availability of their potassic constituents will be determined as well as the effect of lime, organic matter, and the nature and amounts added of different nitrogenous fertilizers. The results are expected to show whether or not the petrographic analyses of a soil can be relied upon to indicate the probable needs of the soil for potash under different cultural practices.

Experiments have been started, too, to determine the cause of unsatisfactory yields on the muck soils of the Eastern section of the State. This work will be developed as a study of the nature of the acidity of these soils and methods will, if possible, be devised for the elimination of toxic compounds present in them.

EXPERIMENTS WITH TOBACCO

For the past few years quite a large amount of experimental work is being conducted at Oxford under the immediate direction of E. G. Moss, and at Reidsville with E. H. Mathewson in charge. This work is being carried on in co-operation with the Office of Tobacco Investigations of the U. S. Department of Agriculture. Below is given a brief resumé of some of the more outstanding results.

At Tobacco Branch Station Farm

Main Fertilizer Experiments.—There are 36 fertilizer plats in this experiment on which are being tested out the different sources of nitrogen, phosphoric acid, and potash. One half of each of these plats dolomitic limestone has been broadcasted at the rate of one ton per acre. Results thus far secured show dolomitic limestone has increased the yield on all the plats, that there was less leaf spot trouble on the limed end than on the unlimed end of plats, and that the limestone did not depreciate the value of the tobacco, while previous experiments with the use of ground calcite showed the calcite did darken the

tobacco. For that reason we would not recommend the average ground limestone for tobacco, but do not hesitate to recommend dolomitic limestone where magnesium carbonate runs as high as 25 per cent.

Special Potash Field Work.—The Special Potash Experiment consists of 20 plats on which is used different amounts of sulphate and muriate of potash, with and without ground limestone. The nitrogen and phosphoric acid under those plats remain constant and the potash varies from 12, 24, 36 to 80 pounds of actual potash per acre derived from sulphate and muriate of potash. Results show that 36 to 40 pounds of actual potash per acre is apparently about the right quantity to use for best results on the type of soil, mapped as the Durham sandy loam. The muriate of potash gives an increased yield over the sulphate of potash, but does not improve the burning quality.

Magnesium and Potash Experiments.—This consists of 18 plats on which is used Trona muriate, German muriate, Nebraska sulphate, German sulphate, double manure salts, and kainit. On one series of plats is applied dolomitic limestone at the rate of 1,000 pounds per acre in the drill at the time of applying the fertilizer. On the other series is used ground limestone derived from calcite. On the third series no lime was applied. Results show that on these plats where dolomitic limestone was applied no "sand drown" was present and both yield and quality of tobacco were improved. On plats where calcite was applied "sand drown" and leaf spot were serious on all plats, except where double manure salts and kainit were used. On series where no lime was applied both "sand drown" and leaf spot were serious, except where double manure salts and kainit were applied and the yield of tobacco was 35 to 40 per cent less than on the other two series of plats.

Special Fertilizer Tests.—These consist of 12 plats on which were used C. P. fertilizer materials testing out the effects of magnesium sulphate as compared with magnesium chloride; also studying the effects of sodium chloride and sodium sulphate, and potassium nitrate as compared with dicalcium phosphate. The results in these tests have not been ascertained yet as this was the first year this series of plats were run.

Variety Tests.—We were continuing our work with the different varieties of tobacco which has been carried on for the past several years. We have begun to do some breeding work and selections. The breeding consists of crossing a variety which cures bright and makes big growth and poor body and texture on to a variety which has body and weight but does not cure out as well as some of the others, with the hope of getting a combination which will make a better tobacco than we have at present. It is felt we are getting some very satisfactory results along this line.

Rotation Experiments.—We are trying out several rotations of two, three and four years duration. The one that gives, perhaps, the most satisfactory results is the three-year rotation which consists of tobacco, first year; oats second year, followed by cowpeas or soybeans for hay or to be plowed under as conditions may justify; Abruzzi rye for seed the third year. After the rye the stubble land is to be plowed deep in the fall of the year, to be planted to tobacco the following season. On farms where tobacco land is limited and a short rotation is desired, this seems to be one of the most satisfactory rotations that could be suggested. Our results thus far have shown that where such a rotation is followed the tobacco crop shows improvement both in yield and quality.

Tobacco after Cowpeas.—This experiment has been running for ten years, using cowpeas or soybeans to provide nitrogen, with a liberal application of phosphoric acid and potash supplied, but no nitrogen is applied of a commercial form. Where tobacco is planted fairly thick in the drill and is harvested by priming, provided it is not topped too low, a crop of tobacco of average quality is produced. There are four crops grown on this land, tobacco followed by oats, oats followed by cowpeas or soybeans plowed under, and land seeded to rye to be plowed under in the spring. This is a two-year rotation; however, we do not recommend such a rotation to be followed indiscriminately, as many farmers would undoubtedly get in trouble and produce tobacco of poor quality, but it could be used with satisfactory results if followed very intelligently.

Permanent Tobacco Seedbed.—A permanent seedbed can be established at a convenient location on the farm, provided it is thoroughly sterilized from year to year with steam. Such a seedbed when once established will grow healthy plants more consistently than a seedbed located at different places. The only handicap to this plan is the scarcity of portable steam boilers on tobacco farms.

At Reidsville

The work being carried on at Reidsville is planned similarly to that being conducted at Oxford. The results there, as at Oxford, were quite striking in showing the marked influence of the use of magnesia in overcoming entirely or greatly reducing the ravages of "sand-drown." It is regretted to have to report that late in the year the work at this farm sustained a great loss in the losing of Mr. Mathewson from the work, to take up work in the Orient with a big commercial tobacco company.

CROP IMPROVEMENT

Adams Project

Project No. 14.—The cotton study of association and inheritance of economic qualities has been continued. This work has consisted of preparation of data and notes for publication and further study of certain smooth seeded types that were not included in the plantings during the past three years, on account of the lack of space. Due to old seed and unfavorable spring weather, a very poor stand was secured in the plantings of this season. Sufficient seed were saved to continue the strains. The results from this project are being put in shape and it is hoped to publish them with the deductions some time during the coming year.

Project No. 15.—The "Place effect" study of cotton conducted in coöperation with the Mississippi Experiment Station has been continued. The unfavorable weather in the spring destroyed so many seedlings that a fair comparison of the two sources of seed was rendered impossible on account of the irregular stand. It is planned to continue this work for another year.

At Central Farm.—The field crop work at the Central Station farm has consisted of trials with new crops, seed selections and cultural studies. In the trial plats were included the Subterranean clover, seredella, Vicia *disperma*, Japan clover (Tennessee strain No. 76), three new varieties of cotton, four new varieties of soybeans, and two strains of the annual sweet clover. The Subterranean clover is a Bureau of Plant Industry introduction from Australia and has given very promising results. Judging from its growth, earliness of seeding in spring and resistance to drought, it will be superior to burr clover for soil improvement and grazing. The young seedlings which volunteered on the plats in the summer withstood the dry, hot weather of August and September. This crop is being tried this fall on a larger scale here and in another section of the State. The narrow leaf vetch (*Vicia disperma*) has continued to show more resistance to the false anthracnose that has been very destructive to ordinary hairy vetch. Seed of the Japan clover, strain No. 76, from the Tennessee Experiment Station, was grown in comparison with ordinary commercial seed. The Tennessee strain has been found to be more upright in growth and much superior in quantity of growth.

Of the new strains of cotton grown for the first time on this farm, Delfos from Mississippi Station has given the best results.

The seed improvement work includes plant-to-row and increase plats of cotton, corn, soybeans, wheat, rye and sorghum. On this farm all of the cotton breeding work is confined to strain No. 6 of Mexican Big Boll. It has continued to gain favor in the State on account of its large yield and extra length of staple. In the plant-to-row plats, a large portion of the rows furnished 1 1/8 inch staple and have been unusually productive. The corn breeding work has been continued with the strains of Cocke's Prolific that has been grown on the farm several years. No other seed improvement work of the Division of Agronomy has yielded better returns than the soybean work. Three pedigreed strains of Virginia, three of Haberlandt, and eight of Mammoth Yellow soybeans were increased and compared with the varieties from which they came. The best strains of these varieties have been distributed to the Branch Station farms and to private growers of the State where they are being increased. Haberlandt No. 38 and Virginia No. 11, have shown up well in community tests throughout the Piedmont section. The selection of Mammoth Yellow for higher oil content has been continued.

Some interesting results have been secured from a chance hybrid between the Haberlandt No. 38 and Virginia soybeans. Some F3 plants were grown this year. In the lot was considerable variety of types ranging between the two parent varieties. One of the most promising selections from the F3 material is the progeny of one plant, all of which are of the Virginia type of growth, having yellow seed instead of brown. The main stems are stiffer than the original Virginia, furnishing a more upright plant at the time of harvest.

Strain No. 12 of Leap's Prolific wheat has been continued, though the 1922 crop was not offered for sale on account of the mixture of volunteer oats and rye in it. Seed of it have been recleaned by hand for further increase this fall. Through the variety studies on this and other farms it was found that the earlier North Carolina wheats are more productive on the average North Carolina soil. Our average yield for the State of approximately 8 bushels of wheat per acre indicates that a large portion of our wheat is grown on land low in fertility. The variety tests made upon soils which produced 15 to 20 bushels per acre have been misleading when the average conditions of our State are considered. The tests on soils producing 8 to 10 bushels per acre have shown conclusively the need for an early maturing variety of wheat. To meet this need, the Division of Agronomy has started work on the selection and increase of an early variety known as Alabama Blue Stem. This variety is an early strain of Purple Straw which has given splendid results in field trials during the past three years. The strain was secured originally from the Alabama Experiment Station. The pedigreed strain of Abruzzi rye was increased on a larger scale. Several plant selections were made for

the plant-to-row comparison and increase. Three hundred bushels of this strain were sold to growers of the State to be grown for seed purposes. On account of the high production of the Honey or Japanese Seeded Ribbon sorghum in the variety tests, work has been started in the selection and increase of seed of this variety. Plant selections have been made and are being examined for juice and sugar content.

The Field Culture work has consisted of cotton spacing tests in which distances between hills were as follows: "No thinning," 8, 12, 18, and 24 inches in 4-foot rows. The unthinned plats have continued to yield highest and in each of the other plats the thicker spacing has yielded more than the thinner spacing.

Hay Mixtures.—Small broadcast seedings of different varieties of cowpeas, soybeans, and sorghum, were planted to determine the varieties which matured nearest the same time and were best suited for hay mixtures. Data was secured upon the habit of growth and time of maturing of five varieties of sorghum, seven varieties of cowpeas and six varieties of soybeans.

At Mountain Branch Farm.—The work at the Mountain Branch farm has consisted of seed selection with corn and soybeans, and variety tests of wheat, oats, rye and soybeans. The plant-to-row breeding of Bigg's corn has been continued with encouraging results. This Branch Station has become a source of good seed in that section of the State and its seed are likely to become more popular on account of the recent standing of this corn in community variety tests of that section of the State. The increase of Haberlandt No. 38 soybeans at this farm has been more successful this summer on account of the longer season between frosts. In order to insure its maturity in that section, a large number of plants were selected this fall.

At Piedmont Branch Station.—The field crop work of this farm consists of cultural studies of wheat and oats, and improvement work with cotton, corn, wheat, oats and Abruzzi rye. The past season completed a six-year test of rate and date of seeding wheat and oats. The results of this test are being prepared for publication. The pedigreed strains of cotton, wheat, oats and rye are being increased for sale to growers of that section.

At Tobacco Branch Station.—The Tobacco Branch Station has been used for the increase of any early strain of Purple Straw wheat, Abruzzi rye, and seed corn.

At Edgecombe Branch Station.—At the Edgecombe farm, seed improvement work with Mexican Big Boll cotton and Biggs' corn has been continued. The Mexican cotton has been isolated down to one pedigreed strain, No. 18. This strain has less vegetative growth than the original strain and has proven more productive. The staple is $1\frac{1}{16}$ inches and its yield has been equal to that of Cleveland Big Boll,

our highest yielding short staple cotton. The corn work at this farm has been delayed by the introduction of two new varieties last spring. The number of varieties will be reduced to one and new selections will be made this fall. Two hundred bushels of improved cotton seed were sold from this farm last season, and 1,200 bushels will be offered this season.

At Coastal Plain Branch Station.—The work at this farm has consisted of seed improvement of Cleveland Big Boll cotton and the increase of two pedigreed strains of soybeans from the Central Station farm.

At Blackland Branch Station.—At the Blackland farm work has been continued on the improvement of Latham's Double corn for that section. Special attention is being given to the selection of seed which will give a firmer corn, shorter shanks, better shucks covering and a higher yield. The seed plats of this season have some very promising strains.

In closing this report, I wish to commend most heartily the fidelity to duty of each individual member of the working staff of the Division of Agronomy. Dr. Winters and his co-workers have actively pushed the experimental work in crop improvement; Mr. Pate in soil fertility; and Mr. Moss and Mr. Mathewson in the tobacco investigations.

Respectfully submitted,

C. B. WILLIAMS,
Chief, Division of Agronomy.

REPORT OF THE ANIMAL INDUSTRY DIVISION

To the Director:—The following report sets forth the fundamental lines of work which have been conducted by the Experiment Station workers during the past fiscal year. It is not necessary to state that it would be impossible to go into the details of this work because of the magnitude and variety of subjects on which work has been done. The work of the Animal Industry Division is not only going along well but the scope and influence of the work is constantly broadening as shown by the extraordinary number of calls for information from our investigators in different lines of work.

The following subjects covered are of State-wide importance and many of them are of South-wide importance. The latter is particularly true of the work being done in the Experiment Station and represented by such problems as soft pork, mineral requirements of growing animals, effect of cotton-seed meal on the health and reproduction of breeding animals, and the digestive co-efficiency of feeds in fowls.

ANIMAL NUTRITION

J. O. Halverson, *In Charge*
Assistants, F. W. Sherwood and B. Naiman

1. Soft Pork Studies.

The following feeding projects, in cooperation with Mr. Hostetler, have been successfully completed; analytical work on Soft Pork Experiment 5 is being completed and data worked up on all experiments with which will be incorporated a review of the Soft Pork Investigations.

Completed to Date.

1. (a) Lot feeding to 108 lb. pigs on peanuts;
   (b) On peanut meal, both for 131 days.
2. Individual feeding to 150 lb. pigs for 70 days.
3. Individual feeding to 120 lb. pigs for 77 days.
4. Individual feeding 67 lb. pigs for 110 days.
5. Individual feeding to 103 lb. pigs for 74 days, with hardening feeds.

Projected Work.

The complex effect of food on the body carcass of the hog is pronounced. Three distinct lines of attack are contemplated, given briefly in separate report.

2. The Nutritive Value of the Peanut.,

These studies are nearing completion; the following are completed:

(a) The raw peanut without hulls but with sheath.

(b) The roasted peanut without hulls, but with sheath.

(c) Peanut meal without hulls.

(d) The study of Nutritive Value of peanut meal in the form of baked bread, without the addition of wheat flour, will take considerable more work. The unexpected results obtained tend to give futher insight into the feeding value of the heated peanut meal and its deficiencies.

(e) Studies are now under way supplying the deficiencies of the peanut kernel by means of the peanut leaf itself, soybean leaf, and alfalfa leaf in varying amounts.

3. Mineral Supplements, Chiefly Calcium, for Southern Animals.

One phase of this problem of practical importance in limestone-free regions is the calcium content of commercial mixed feeds. Two years' work, including the analysis of 120 mixed feeds containing six or more feed ingredients exclusive of salt, has been done in coöperation with the feed laboratory. This work is completed ready for publication under the title of "The Calcium Content of Mixed Feeds in Relation to the Feeding Requirements of Animals," by J. O. Halverson and L. M. Nixon.

4. The Nutritive Quality of Butter from Cows Fed Exclusively on Dry Feed, Cottonseed Meal and Hulls. (Combs and Curtis Project).

By feeding the butter from such dry-fed cows to growing albino rats, an attempt is made to ascertain whether fat Soluble A is present in the normal amount. Six series of such feeding experiments are nearing completion. This work is being done on the butter-fat on hand. Certain definite results have been obtained, but more butter-fat is needed to eliminate the influence of the length of storage upon the fat-soluble A content.

5. Publications—Year, 1922.

(a) Extension Pamphlet—The Optimum Diet with the Relative Importance in the Diet of Fruits, Vegetables and Milk.

(b) The Need of Milk in the Diet.—Sunday edition News & Observer.

(c) The Calcium Content of Mixed Feeds in Relation to the Feeding Requirements of Animals, by J. O. Halverson and L. M. Nixon.

N. C. Academy of Science, May 19, 1922, University of North Carolina.

Southeastern Meeting: Feed, Food and Drug Officials, Asheville, August 24, 1922.

Other Activities:

(a) A Series of Lectures and Demonstrations were given on The Effects of Various Diets before the Annual Conference of Home Demonstration Agents.

(b) Co-operated with the Home Demonstration Division at the State Fair.

(c) Co-operated with the Extension Division of Dairying in the Charlotte Milk Campaign and Statesville Live Stock Show with exhibits.

SWINE INVESTIGATIONS

EARL H. HOSTETLER, *In Charge*

The following special experiments were carried out during the past year:

1. Fish Meal for Swine.

Object: To determine if pigs of different weights will consume enough fish meal in the ration to transmit a fishy flavor to the meat.

Plan: (a) To allow two pigs of different weights to have fish meal and shelled corn from a self-feeder.

(b) To feed one pig 10% of fish meal in the ration.

Record: Table 1. Fish Meal for Swine.

Pig No.	Initial Weight	Final Weight	Days on Feed	Feed Consumed	
				Shelled Corn	Fish Meal
34	126	280	114	888	19
36	63	95	43	230	15
18	128	321	118	743	82

Pigs No. 34 and 36 were fed the shelled corn and fish meal in separate compartments of self-feeder, while Pig No. 18 was fed a mixture containing 9 parts cracked corn and one part of fish meal. It is interesting to note the variation in the amount of fish meal consumed by Pigs No. 34 and No. 18 since they were of practically the same initial weight and on feed practically the same number of days.

No "fishy" taste was detected in any of the meat from these three pigs which would seem to indicate that the danger of tainting pork from feeding fish meal to swine is negligible.

Results: No "fishy flavor" was detected.

2. Soft Pork Studies in Coöperation with J. O. Halverson.

A. Individual Work.

Object: To determine the effects of feeding various amounts of oil (peanuts) on the carcass of pigs of various weights; keeping the energy and protein equal in each case.

Plan: (a) To make up rations containing approximately 8, 12, 16, and 20 per cent oil, then in addition to these four rations have one ration containing peanuts alone and another ration which shall be used as a check, containing 60% corn meal, 30% shorts, 5% tankage and 5% linseed meal.

(b) This work as planned will necessitate only one pig on each ration.

Record: Table 2, Soft Pork Investigations with Individual Pigs.

No. of Experiment	No. Pigs Used	Average Final Weight	Average Daily Gain	Feed per 100 pounds Gain	Cost per 100 pounds Gain
2	5	260	1.56	335.0	$ 14.21
3	6	227	1.41	327.0	12.50
4	7	218	1.43	286.1	11.23
5	5	224	1.69	332.0	8.79

Results: The results so far seem to indicate that oil is the chief factor in making soft pork, although enough work has not been done to make it conclusive.

B. Lot Work.

Object: To determine if the size of the pig, when he is put in the finishing lot, after being fed on so-called softening feeds, is a factor in determining the firmness of the carcass after a 60-day finishing period on shelled corn and tankage self fed.

Plan: To feed 30 pigs as soon as weaned on peanuts alone for at least eight weeks. Thereafter to divide these 30 pigs into three lots of ten pigs each, using pigs in Lot 1, weighing approximately 90 pounds; in Lot 2, weighing over 100 pounds and in Lot 3, weighing less than 80 pounds.

Record: Experiment in progress.

Results: Incomplete.

3. Soft Pork Studies in Co-operation with Bureau of Animal Industry.

Object: (a) To determine the effects of feeding peanuts from a self feeder in a dry lot, and the effects of grazing soybeans with a 2½% ration of shelled corn, upon the carcass.

(b) To determine the effects on the carcass of pigs by finishing them in a dry lot for 12 weeks on corn and fish meal, self fed, after 8 weeks on softening feeds.

Plan: To use 12 pigs on peanuts and 12 on soybeans, making shipments of three pigs to the Bureau of Animal Industry at intervals of four weeks each, beginning with the close of the grazing period.

Record: Experiment in progress.

Results: Incomplete.

4. Exhibit of Pure Bred Duroc Jersey Swine at 1922 North Carolina State Fair.

Object: To determine the merit of our hogs as compared with others in the show ring.

Plan: To use such animals in the herd as are available for this purpose.

Record: Fifteen hogs were entered in the show and competed in a creditable manner.

Results: The winnings amounted to $91.00.

Edgecombe Branch Station Farm

The herd of grade Berkshires that has been kept at this farm is being disposed of as rapidly as possible.

In May, 1922, nine pure bred Hampshire gilts and a Hampshire boar were purchased for this farm and will be maintained to produce pigs for experimental work and to use for demonstration purposes.

The special experiments completed at this farm during the past year are as follows:

1. Cost of Raising Pigs to Weaning Age.

Object: To determine the cost of producing pigs to the age of ten weeks.

Plan: To use the farm herd for this purpose.

Record: Reported in Experiment Station Bulletin No. 244.

Results: Each pig cost $4.07.

2. Peanuts for Swine.

Object: (a) To determine the amount of pork produced by a given area of peanuts.

(b) To determine the condition of the carcasses after pigs have been grazed on peanuts for 8 weeks.

(c) To determine the effects of an 8 weeks finishing period on corn and tankage after pigs have been grazed for 8 weeks on peanuts.

Record: Table 3. Peanuts for Fattening Swine.

A. Grazing Period.

Period: September 27, to November 22, 1921—56 days.

No. in Lot	Ration	Average Final Weight	Average Daily Gain	Feed Per 100 Pounds Gain Peanuts	Cost Per 100 Pounds Gain
18	Peanuts	151.9	.87	.76 A.	$11.40

B. Finishing Period.

Period: November 22, 1921, to January 17, 1922—56 days.

No. in Lot	Ration	Average Final Weight	Average Daily Gain	Feed Per 100 Pounds Gain		Cost Per 100 Pound Gain
				Shelled Corn	Tankage	
9	Shelled Corn and Tankage	238.4	1.95	370.8	30.9	7.70

Prices Used:

Shelled corn per bu	$ 1.00
Tankage per ton	70.00
Peanuts per acre	15.00

Results:

1. One acre of peanuts produced 151½ pounds pork.

2. None of the pigs were strictly "hard" after an 8 weeks finishing period on corn and tankage.

NOTE: For some unaccountable reason the gains made on peanuts during this experiment were extremely low.

3. Record of Farm Work Animals.

This experiment was closed December 31, 1921, and a complete record of the work done is shown in September, 1922 Bulletin of the Department of Agriculture.

Blackland Branch Station

The swine work at this farm was begun in January, 1922, by the purchase of a car load of pigs in South Georgia. Six of these pigs were retained on the farm at the close of the following experiment for use as brood sows.

The special experiment carried out is as follows:

1. Marketing Corn in Eastern North Carolina Through Hogs.

Object: (a) To determine if the corn grown on the farm could be marketed through hogs more profitably than to be sold as grain.

(b) To compare tankage and fish meal as supplements to corn for fattening swine.

Plan: (a) To purchase one carload of pigs in South Georgia and feed them out on corn raised on the farm, for a sufficient length of time to make two carloads of hogs for market.

(b) To divide the pigs obtained into two equal lots, feeding lot 1 on shelled corn and fish meal, and lot 2 on shelled corn and tankage, using three self feeders in each lot.

Record: Table 4. Tankage vs. Fish Meal.

Period: February 1 to April 12, 1922—70 days.

Lot No.	No. in Lot	Ration	Average Final Weight	Average Daily Gain	Feed Per 100 Pound Gain			Cost Per 100 pounds Gain
					Shell Corn	Fish Meal	Tankage	
1	68	Corn and Fish Meal	151.5	1.16	330.3	43.5	----------	$5.14
2	67	Corn and Tankage	146.9	.96	364.5	----------	49.8	5.83

NOTE: On March 16, 40 hogs out of Lot 1 and 29 hogs out of Lot 2 were sold.

Results: (a) The corn was marketed through the hogs for $1.10 per bushel instead of 65c, the prevailing price when the experiment was begun.

(b) Fish Meal was more valuable as a supplementary feed to corn than tankage.

Piedmont Branch Station Farm

A pure bred herd of Poland China hogs is kept at this farm for experimental and demonstration purposes.

1. Cost of Raising Pigs to Weaning Time.

Special experiments conducted during the past year are as follows:

Object: To determine cost to produce pigs to weaning age—70 days.

Plan: To use all sows and litters for this purpose.

Record: Reported in Experiment Station Bulletin No. 244.

Results: Each pig cost $3.97.

2. Value of Soybean Pasture for Swine.

Object: To determine value of allowing pigs to graze soybeans, beginning the test about time the beans are in the "dough stage."

Plan: To use 16 spring pigs and allow them a 2% ration of shelled corn 9/10 and tankage 1/10, in addition to the soybeans.

Record: Table 5. Soy Bean Pasture for Swine.

Period: August 31, to October 13, 1922.

No. in Lot	Ration	Average Final Weight	Average Daily Gain	Feed Per 100 Pounds Gain		Cost Per 100 Pounds Gain
				Grain	Pasture	
16	Soybean Pasture with Grain	111.6	.59	295.0	.547 A.	$11.24

RESULTS: Pigs made only .59 pound average daily gain.

NOTE: The area used was seeded to soy beans, but because of a late frost one-half acre was replanted to cow peas. The cow peas were beginning to dry up when the pigs were turned into the field.
RECORD: Table 4. Tankage vs. Fish Meal.

3. Feeding of Farm Work Animals.

This work is being carried on at the present time in the same way as in former years, but new work will be undertaken as soon as a definite plan can be decided upon. The results of the past seven years are shown in the September, 1922, Department of Agriculture Bulletin.

Co-operative Project with U. S. Department of Agriculture

1. Soft Pork Work.

The eight States that are co-operating in soft pork work this year, ship all hogs to the Bureau of Animal Industry Farm at Beltsville, Md., to be slaughtered. After these hogs are slaughtered the carcasses are held in the cooler at an approximate temperature of 36° F. for forty-eight hours. At the close of the cooling period a representative committee makes a physical examination of these carcasses to determine their condition.

This committee is composed of the following men:

Earl H. Hostetler, Raleigh, N. C., representing the experiment stations.

Howard Smith, Baltimore, Md., representing the packers.

Dr. Walters, Washington, D. C., representing the Federal Department.

In addition to the physical grading made by the above committee, a

chemical examination is made on one sample of back fat and one sample of leaf fat from each carcass.

In the work that has been done up to the present time approximately 1,000 hogs have been used and in addition to the eight States that are coöperat ng th s year the Bureau of Animal Industry is including tests made at Beltsville, Md. and at McNeill, Miss.

DAIRY EXPERIMENTATION

STANLEY COMBS, *In Charge*

Central Experiment Farm

1. Object: To Determine the Effect of Cottonseed Meal on Cows and Heifers in Reproduction. (Coöperative, Combs and Curtis).

This herd consists of sixteen grade Ayrshire cows in the milking herd with six yearling heifers and a herd bull. Two of these cows have been in the herd since 1915. The other fourteen were purchased from the Pinehurst Dairy as calves and during January, 1920, as yearlings. They were divided into lots and fed as follows:

Lot No.	Grain Ration	Roughage
I	Cottonseed meal—1 part	Cottonseed hulls—ad libitum
II	Cracked Corn	Corn stover—1 part Corn silage—2 parts } ad libitum
III	Cottonseed meal—1 part Crushed corn—1 part	Cottonseed hulls—1 part Corn silage—2 parts Corn stover—1 part } ad libitum
IV	Cottonseed meal	Corn silage—ad libitum
V	Cracked corn—3 parts Wheat bran—1 part Linseed meal—1 part	Alfalfa hay—1 part Corn silage—2 parts } ad libitum

This young herd was bred to calve the first time during the fall of 1921. On these rations indicated in the first four lots above some of the animals aborted before five months, while others carried their calves the full length of time. However, the calves that were carried full time were weak, small, some blind, and none lived over sixty hours. Those aborted were deformed, blind, and some appeared to have very soft bones and showed oedema in various portions of the animal body.

The following is a brief discussion of the work of these cows as individuals:

Cow No. 102 aborted twins in 1921. Never came into milk. Ration changed to cottonseed meal 90 pounds, calcium carbonate ¾ pounds, butter fat 2 pounds, casein 10 pounds, early in the year. She was bred April 3, 1922. Has gained in flesh and seems to be safe with calf.

Cow No. 103 aborted October 1921. She is being continued on the same ration this year. Was bred March 24, 1922, and is with calf.

Cow No. 104 failed to breed in 1921. Her ration was changed to 100 pounds cottonseed meal and ¾ pounds calcium carbonate. She was bred January 19th. Failed to conceive, and died during the summer. Her ovaries were diseased.

Cow No. 106 produced a calf that lived 36 hours during 1921. Her 1922 ration consists of cottonseed meal 90 pounds, casein 10 pounds, calcium carbonate ¾ pounds. She was bred January 21, 1922, and still carries her calf. The cow is blind.

Cow No 107 aborted July, 1921. Early in November, 1921, she developed cataracts in both eyes. She is now totally blind. Her ration for 1922 is cottonseed meal 100 pounds, butter fat 2 pounds, calcium carbonate ¾ pounds. She was bred April 23, 1922, and appears to be with calf.

Cow No. 105 calved normally in check lot during 1921. She was transferred to Lot 1 early in the year. In about two months she became weak and sluggish, finally developing a severe fit or spasm. After suffering from this for four or five hours we were able to help her up and move her to a shed, and shade. She appeared to be suffering from some kind of poison. However, rats suffer in much the same way when suffering from vitamine starvation. Thinking this might be the trouble, she was given yeast. One pound was given before she regained her appetite. She has received one pound each week since this time. She was bred March 28th and again at a later date. She is probably with calf at present.

The four cows in Lot 11 produced calves last year that were weak and died soon after birth. Several years ago Wisconsin found a ration made up entirely from the corn plant satisfactory. Therefore, half this lot was changed to their ration which consists of cracked corn 5 pounds, corn gluten meal 2 pounds, and corn stover 7 pounds. Three of these cows are due to calve during the next few days while the fourth is due in January, 1923.

Cow No. 402 aborted in 1921. Her ration was changed to cottonseed meal 90 pounds, casein 10 pounds, and calcium carbonate ¾ pounds. She was bred January 18, 1921, and dropped a living calf weighing 62 pounds on October 30th. This calf was very weak, but by careful feeding we have been able to keep it alive so far.

Cow No. 403 aborted during 1921. Was kept on the original ration and bred March 1, 1922. She aborted again July 27, 1922. Her ration was changed to cottonseed meal 96 pounds, U-Cop-To Special Steam Bone Mineral Meal 4 pounds, together with Fleischmann's yeast each week. She will be bred during November, 1922.

Cow No. 303 aborted during 1921. Cow No. 304 dropped a weak calf during 1921, which soon died. Both cows were continued on the same ration for another year. They were bred on April 12th and March 23d respectively and are both with calf at present.

Lot No. 5 is our check lot and all animals are in good condition and have never been off feed. They produce normal calves each year. Two have already calved.

The milk produced by these experimental cows during the winter and spring of 1922 was fed to calves with the object of determining its growth producing quality. Nineteen calves were used. Curves have been plotted showing the effect upon the milk produced by these various rations. Calves fed milk produced by the cows in Lot 1 made only about one-half as much gain in weight during the first six months as did the calves that received milk produced in Lot 5.

The calves fed milk from Lot 5 made the best gains. Lots 3 and 2 came in for second place. Lot 4 came next, while the milk produced by the cows in Lot 1 made the poorest gains.

Data is also available showing the amount of milk produced by each cow in the various lots and its cost per hundred pounds.

Coastal Plain Station Farm

2. Herd Development.

A herd of fifty-three registered Jerseys is now on this farm. This herd may be divided as follows:

23 cows in milk
10 bred heifers
15 open heifers and calves
1 herd bull
3 young serviceable bulls
1 bull calf

Herd development work has been given first consideration during the last year, the same as in the past. The daughters of Eminent 19th are all in milk and most of them have been tested officially and have won their Register of Merit Certificate. Some have made good records. Pender Eminent Lass E, No. 369040 completed her second re-test in July with 13,774 pounds of milk and 792.48 pounds of fat, Class A. A. This makes her the Grand Champion Fat Producing Cow of North Carolina over all breeds and entitles her to the American Jersey Cattle Club's Gold Medal. She is the third and best daughter of Eminent 19th to win a gold medal. Thus, when Lass E. finished her record, Eminent 19th, became the South's first and only Gold Medal Bull. Only twenty-four such bulls have ever been produced in the United States. His daughters hold the Junior two-year-old Class State Record for production, the Senior three-year-old, and the Junior four-year-old in addition to the Grand Champion of all breeds. In considering all his Register of Merit daughters that are out of Register of Merit dams, it is found that he has increased their production 35%. This is a remarkable increase considering the fact that the dams were good producers as is indicated by their official records. His daughters out of ordinary, or average, cows would show a larger increase than this.

A few of the granddaughters of Eminent 19th are not in milk. Ten more are safe with calf to a son of Eminent 19th. They are a nice appearing lot of heifers and give promise of maturing into high producing individuals. They are sired by Rumina's King No. 160969. King is a line bred "Eminent" bull. Search is not being made for a suitable junior herd sire to breed to the daughters of King.

Owing to the lack of silage, not much experimental feeding was accomplished during the past year. This work consisted largely of the continuation of the projects which were already started. The coöperative velvet bean meal work conducted with the South Carolina and Alabama Stations was completed. In this experiment it was quite noticeable that the cows preferred the wheat bran with cottonseed meal rather than the wheat bran and velvet bean meal. In fact, under pasture conditions we found it necessary to add crushed corn to the ration in order to get the animals to consume enough of the grain ration to maintain their milk flow. The cows consuming the velvet bean meal lost flesh more than animals receiving cottonseed meal.

The calf feeding work was discontinued during the year; i. e., no more animals were added to either of the two lots. The animals already started on the work were continued on the ration. They should all finish during the coming year. This work was a comparison of the feeding value of peanut meal with cottonseed meal as a protein carrier for maturing dairy heifers. So far the actual results show very little difference in the

feeding value of these two feeds. However, cottonseed meal is much more readily obtained, is usually a few dollars cheaper per ton, and gives less trouble while in storage. The peanut meal seems to cake and finally mould when held in the feed room for some time. These are factors worth considerable consideration. Peanut meal should have a place in livestock feeding. It is a good feed and will add variety to the protein content of the ration.

During the spring and summer the milk produced daily by this herd was summarized for the purpose of determining the effect of weather conditions upon the daily production of milk. Two years and six months records have been reviewed. The weather report has been obtained from the Wilmington weather bureau covering the same period of time. The milk produced during the early spring months shows a variation of five gallons per day; i. e., the days with 75% or more of sunshine show an increased production of this amount over those days with less than 75% of sunshine. The humidity reports have not yet been assembled, but it is planned to do this at a future date.

COMPARISON OF 1921 PRODUCTION WITH 1922 PRODUCTION

Month	Cows in Herd	Milk	Fat	Milk	Fat	Cows in Herd
October	28	13491.1	698.90	9934.7	527.90	22
November	28	13845.1	774.48	10373 5	589.26	22
December	25	13722.1	736.10	11620.7	633.72	22
January	25	12223.9	665.94	12216.6	648.15	22
February	26	10385.0	518.90	12468.0	654.81	23
March	26	14027.2	707.65	16266.5	844.46	23
April	26	13193 5	682.40	14003.8	713.52	23
May	25	14602.6	749 20	10674.4	546.99	22
June	25	12906.3	619.72	9610.3	496.86	22
July	24	12104.4	613.12	11053.6	560.52	22
August	24	12126.7	598.88	11188.7	562.36	22
September	24	9659.2	488.07	9716.7	500.22	23
Totals	25½	152,287.1	7823.36	139127.5	7278.77	23¼
Total values		$7,081 35		$6,469.41		
Average production per cow		5972.0	306.5	6229.5	325.9	

Four years ago only two cows in the herd had ever produced as much as 300 pounds of fat in one year and they each produced this amount once only. The average for the past two years has been above 300 pounds.

The operating expenses have all been taken care of during the past two years by the cash receipts. The increase in the value of the herd and manure have been sources of profit to the farm.

POULTRY INVESTIGATIONS AND PATHOLOGY

Dr. B. F. KAUPP, *In Charge*

1. A Study of the Diseases of the Fowl:

Encephalocele of a Baby Chick.—A case of encephalocele of a baby chick was studied in one case. The eyes were only partially formed with no eyelids. There was a fleshy looking mass protruding from the top of the skull which upon microscopic examination proved to be a portion of the cerebrum.

A Horny Growth from the Foot of a Hen.—From the top of a Barred Plymouth Rock hen there had developed a horny growth one and one-half inches in diameter at the base and more than two inches long.

Edema of the Larynx.—Edema of the pharyngeal mucous membrane was studied in a Pit Game cock. The mass measuring more than two inches long protruded from the mouth.

Polypus of the Oviduct.—A case of a tumor measuring two cm. in diameter was located in the oviduct of a hen. This prevented the hen from laying. The tumor was attached to the wall by means of a pedicle.

Many fowls have been sent to the laboratory for study and diagnosis and two outbreaks of a disease resembling fowl typhoid are now being studied and will be reported on in full in the next annual report. These cases were treated by a vaccine made from the germs isolated from the two respective territories. The vaccine proved quite efficient in the treatment.

2. Laboratory Studies.

Normal Temperature of the Adult Fowl.—In order that we may know, from a clinical standpoint, the normal temperature of the fowl, many series of tests were made. This included taking temperatures of the same fowls in the morning, noon, evening, and at midnight to determine the average day temperature and also when the surplus temperature was eliminated from the body. It was found that the normal temperature of the adult fowl is 107.4° F. and at night the temperature will fall to 105° F. This knowledge has been of value to us in the study of Fowl Typhoid in which the temperature ranges as high as 114.5° F. or 7° of fever.

The Study of Temperatures of the Houses with the Draft System and by the Diffusion System.—The unit system house was used in these tests one end being ventilated by diffusion and the other by draft. It was found that the difference in temperature depended upon the direction of the wind. There was from one to four degrees difference which makes ventilation by draft slightly in favor of ventilation by diffusion in the summer time.

Rate of Growth of Single Comb White Leghorns.—A growth curve was established at the central plant for the pullets of the S. C. White Leghorns from hatching to 34 weeks of age or the time when the pullets go into the laying pens.

The Relative Value of the Various Vegetable Proteins was published in Poultry Item in a series of ten articles. Animal food is necessary to place pullets into heavy early egg production. Animal food is essential for best growth. When pullets are reared on very limited animal food when put into the laying pens and given a mash with animal food they soon come into full laying.

In the Veterinary Journal was published under the heading of "A Contribution to the Study of Tumors of the Domestic Fowls" the result with illustrations of a compound tumor from a Golden Wyandotte cock *lympho Carcomas* of S. C. White Leghorns, *Myxo-Sarcoma* of a Barred Plymouth Rock cock, and an interesting case of volvulus or gut tie of a hen.

The effects of velvet bean meal upon growing chicks was published in the Journal of the American Association of Instructors and Investigators in Poultry Husbandry.

An article on the rate of growth of the S. C. Rhode Island Reds, both males and females, was published in Poultry Science.

The Effects of Weather Temperature upon the Temperature of the Hen.—It was found by taking the temperature of the same fowls the first day of each month that the temperature of a fowl that was, say 107° F.

in the winter time, may be 110.5° F. in the summertime on a hot noonday. The temperature of the body of the hen is affected by the temperature of the surrounding atmosphere.

The Normal Respirations of the Fowl.—A study was made of the number of normal respirations made by the hen per minute. It was found that an average sized cock of 8 or 9 pounds will breathe normally about twenty times a minute. A hen of the same breed will breathe about thirty-six times a minute. This knowledge is of value in the study of disease. A hen with fowl typhoid with a temperature of 114° F. breathes 120 times a minute.

The Effects of Feeding Hours on Egg Production. Extending the length of feeding hours on pullets is profitable, but it is not profitable to give a constant 14 feeding hours to laying hens. The second year shows a decrease in egg production.

After the first of April the extra light should be gradually lessened to normal daylight till the following late fall or winter when the short days and high priced eggs attain.

How Long Does a Hen's Toe Nails Grow in 365 Days?—This question was answered by measuring the toe nails of two Barred Plymouth Rock hens at the end of 365 days. They had grown 1.9 cm.

The Fate of Grit in the Gizzard.—It was found that a fowl may go 365 days without replenishing its grit. At the end of this time there was enough grit in the gizzard of the remaining two hens to grind the food, as shown by the fact that the hens were in perfect health and in good flesh.

The Cost of Hatching Baby Chicks Artificially.—When the eggs cost 30c per dozen for hatching, a chick was produced for 9c and when the eggs cost $1.50 per setting of 15 eggs the chicks cost 29c.

The Effects of Latitude on Egg Production.—This work is in its third year. In the second year the results were similar to those of the first. There are more possible hours sunshine at Winnipeg, Canada, but there are more actual hours sunshine at Raleigh, N. C. The hens at Raleigh weighed heavier than those at Winnipeg, and the birds at Raleigh laid more eggs per hen than those at Winnipeg, Canada.

The Digestive Coefficients of Poultry Feeds.—A summary is being made of the seven years' work on the determination of the digestive coefficients of poultry feeds conducted on poultry. This covers 19 feeds and 101 individual tests. To the world's work of 89 individual tests we have added 101, and from this have compiled a table of digestible nutrients of 30 poultry feeds based on poultry digestion trials.

3. Assistance to Fairs of the State.

During the fall several fairs were given assistance by sending senior students to judge poultry.

Mr. W. F. Armstrong, a senior student in Agriculture, specializing in poultry, judged the Forsyth County Fair at Winston-Salem and also the Johnston County Fair at Smithfield, N. C.

Mr. G. L. Booker, a senior student in Agriculture, specializing in poultry, judged the poultry at the Person County Fair at Roxboro, and also the Fair at the Franklin County Fair at Louisburg, N. C.

Mr. J. F. Johnson, a senior student in Agriculture, specializing in poultry, judged poultry at the Old Hickory Fair at Lexington, N. C., and also at the Knightdale Community Fair in Wake County.

4. Extension Lectures by Members of Poultry Organization.

February 17, 1922, Prof. D. H. Hall gave a talk at Farm Life School at Zebulon, N. C.

February 24, 1922, Mr. J. E. Ivey gave a poultry talk at Farm Life School at Cary, N. C.

February 22, 1922, Dr. B. F. Kaupp gave a poultry talk at Method High School at Method, N. C.

May 2, 1922, talk before Central Carolina Poultry Association meeting at Greensboro, N. C., on European Poultry Observations.

By Dr. B. F. Kaupp.

June 29, 1922, a dissection of a fowl and a description of the course of the feed through the digestive tract. Demonstration of caponizing. By Dr. B. F. Kaupp.

August 6, 1922, A talk before the Farmers' Convention on Culling of Fowls with demonstration. By Dr. B. F. Kaupp.

February, 1922, Dr. B. F. Kaupp gave dissection and description of digestion of the fowl before the Virginia State Veterinary Medical Association at Richmond, Va.

Dr. B. F. Kaupp gave a talk before the Madison Square Garden educational program at New York in January, 1922, on things learned by his European trip of poultry study and gave talks along this same line before the Poultry Science Club, The Research Society, and The Swine Club.

The Mountain Poultry Plant Work

5. Poultry Work at the Mountain Branch Station Farm.

The work intended for the Mountain plant was removed from Statesville to Swannanoa in April, 1922. There was some work during the year done at the Iredell Test Farm.

Velvet Bean Meal Tests.—14 pounds of velvet bean meal were mixed in each 100 pounds mash mixture. The chicks receiving the velvet bean meal with water weighed an average of 0.84 pounds each at the end of eight weeks, while the chicks receiving this same ration with the addition of milk, weighed an average of 1.15 pounds each and the controls receiving no velvet bean meal but ground oats instead, averaged 1.43 pounds each at the end of eight weeks. The control flock produced a pound gain on .319 pounds feed while those on velvet bean meal and milk produced a pound on 4.9 pounds feed and those on velvet bean meal and water produced a pound on 8.1 pounds.

Value of Eggs from a Farm Flock.—The value of the eggs per hen for the year at the Iredell Farm was $3.01 and the number of eggs was 113 per hen. These hens had been culled two years and the start was made from 76 eggs per hen per year.

The Coastal Plain Poultry Work

6. Poultry Work at the Pender Test Farm.

From 100 hens kept at the Coastal Plant $930.30 worth of products were sold, leaving a surplus of 51 fowls at the end of the year in addition to the 100 of the old stock. The net profit per hen, after all overhead had been paid, was $1.67.

Incubator House Experiments.—The experiments with an incubator house built entirely above ground and on the plan of a sweet potato house proved successful up to the hot weather about the middle of May.

Animal Feed Tests.—At this station tests are being run to determine the value of the various animal feeds. It is found that for best results, birds whether growing or laying, must have animal feed such as digester tankage, meat scrap or milk. These three feeds are about equal from a feed standpoint.

Rate of Growth.—The rate of growth of S. C. Rhode Island Reds is being carried on. A growth curve representing normal growth is being determined and plotted. From this we can measure the value of the various feeds.

Cause of Unlivable chicks.—The cause of weak chicks is being studied. It was shown that chicks made weak from improper incubation would cause a poor hatch, heavy loss as growing birds as well as range birds and heavy loss as layers. The birds were not strong and transmitted a weakness to their chicks the following year.

7. Miscellaneous.

Circular Letters Issued.—1,700 circular letters were issued to boost the Seventh Official State Poultry Show November 30, to December 1 and 2, 1922.

There were distributed 2,200 bulletins and reprints.

Correspondence.—During the year 2,196 letters were written to persons inquiring in regard to disease, feeds, feeding, supplies, poultry house construction, where they could buy eggs and breeding fowls, and many other problems confronting the poultry keeper.

State Association Work.—The head of the Department acted as secretary of the State Poultry Association during the year and was its official delegate at the Annual Meeting of the American Poultry Association which convened at Knoxville, Tenn. August 8-12, 1922. He also gave a talk before the Central Carolina Poultry Association which is located at Greensboro, N. C.

Culling Demonstrations.—A culling demonstration was given before the Farmers' Convention at State College the first week in August, 1922.

Articles and Papers.—During the year three technical articles have been furnished scientific journals and thirty-six to the Poultry Press. In addition to this there have been issued two popular circulars for distribution in the State, one on the operation of the incubator and the other on culling and feeding.

BEEF CATTLE AND SHEEP INVESTIGATIONS

R. S. CURTIS, *In Charge*

1. The Effect of Cottonseed Meal on Beef and Dairy Females in Reproduction.

This project has been reported on in detail under the Office of Dairy Experimentation with Mr. Stanley Combs in charge. This work is being conducted jointly by the Office of Beef Cattle and Sheep and the Office of Dairy Experimentation, and it is, therefore, considered unnecessary to repeat the accomplishments on the project at this time.

It may be stated, however, that this is one of the big problems confronting the cattle producers of the South, and more especially in the cotton producing areas where the tendency is to feed large quantities of cottonseed meal. Good progress has been made on the project. A report on progress was made at the last meeting of the Southern Agricultural Workers held at Atlanta, Ga.

Great danger in feeding too much cottonseed meal is shown in the tendency toward abortion and abnormal development of the foetus which seems to be lacking in mineral matter in the bones and otherwise a retarded or incomplete development.

2. Wintering and Summer Fattening of Cattle in Western North Carolina.

The following summary gives the results of wintering cattle in Western North Carolina on various rations, the problem being to determine how cattle can be most economically handled and return the largest profits under these conditions.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Lot 6
Number of steers	25	25	25	25	25	25
Average initial weight per head	831	826	799	795	827	851
Average final weight per head	764	775	740	741	748	776
Total gain or loss in weight 112 day period	−67	−51	−59	−54	−79	−75
Total cost of feed per head 112 day period	$15.34	$16.01	$13.49	$15.34	$15.34	$17.12

The following prices were charged for feeds used:

Cottonseed meal	$ 45.00
Cottonseed hulls	18.00
Corn silage	7.50
Straw	10.00
Mixed hay	30.00
Corn and cob meal	.75
Corn stover	15.00

The rations given below were used in the above experiment:

Lot 1. Hay 10 lbs., cottonseed meal 1 lb., crushed corn and cob 1 lb.

Lot 2. Hay and straw mixed, 5 lbs., corn silage 15 lbs., cottonseed meal 1 lb.

Lot 3. Hay and straw mixed 5 lbs., corn silage 15 lbs.

Lot 4. Hay 10 lbs., cottonseed meal 1 lb., crushed corn and cob meal 1 lb.

Lot 5. Hay 10 lbs., cottonseed meal 1 lb., crushed corn and cob meal 1 lb.

Lot 6. Cottonseed meal 2 lbs., cottonseed hulls 12 lbs.

At the conclusion of this wintering period these cattle were placed on pasture for 140 days with the following gains made by each lot:

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Lot 6
Average daily gain in pounds	2.39	2.30	2.59	2.39	2.82	2.50
Average cost of 100 pounds gain for total period	$2.98	$3.09	$2.75	$2.98	$2.53	$2.84

This work shows conclusively that beef cattle cannot only be produced profitably in Western North Carolina, but also that the use of corn silage

in a wintering ration and cottonseed meal and hulls in a wintering ration are not detrimental in making gains the following summer on pasture.

It has been thought that these two rations produced deleterious effects, but extended work along this line does not so prove.

3. Effect of Cottonseed Meal Upon the Reproductive Qualities of Ewes.

The work which has been done at the Central Experimental Farm and the Piedmont Branch Station along this line shows that when these products are fed in moderation that there is no deleterious effect, either in the condition of the animal or in their reproductive qualities. The work shows that the feeding of cottonseed meal may be practiced safely up to three-fourths of a pound per animal daily and with large sheep as much as one pound per animal daily.

The work at the Piedmont Branch Farm was considerably interrupted last year owing to the fact that all the pastures were plowed up, with minor exceptions, and it was necessary to alter the work somewhat. The above results, however, are clearly evident.

4. Cleansing Sheep of Stomach Worms.

One of the greatest drawbacks to sheep production in this country, and especially in the South, where the rainfall is excessive, is the stomach worm. Up until the past few years this problem has baffled sheep producers and Experiment Station workers. The difficulty has been to get a dosage of treatment of sufficient strength into the stomach of the sheep. It has been found, however, that bluestone or copper sulphate is very effective and treatments under proper conditions will no doubt save large numbers of sheep.

The following treatment has been tried out and found to be effective:

For lambs, one and one-half ounces copper sulphate, 50 c. c. water.

For ewes, three ounces copper sulphate, 100 c. c. water.

This treatment should be given after the sheep have been kept off feed and water over night. This is very essential in order that the treatment does not become absorbed by the food in the stomach.

This concludes the fundamental lines of work which are being performed by the various Experiment Station workers.

Respectfully submitted,

R. S. CURTIS,
Animal Industry Division.

REPORT OF DIVISION OF ENTOMOLOGY

To the Director:—In presenting this report of the work for the year I shall, as suggested by you, include also a brief discussion of the progress or results on all the projects, outlines of which have been filed with you from time to time.

In doing this I must at the outset remark that a great amount of time and labor is expended in ways which cannot be adequately shown in a formal report on definite projects.

CORRESPONDENCE, ROUTINE AND EXECUTIVE WORK

The time of the Chief and Clerk are largely occupied with the many matters under this head. While we have long since ceased to specially stimulate the general correspondence so as to reach the farmers through the county agents, yet the direct correspondence with farmers is considerable and inevitably shows a gradual increase from year to year. Numerous letters are received from county agents. Under such emergencies as the boll weevil problem, and epidemic outbreaks of little-known pests, we are often deluged with inquiries at the very busiest seasons.

Consultations in office, on street, in field, and by telephone, are numerous, not only with farmers and citizens but with agents for insecticides and machinery, with workers of other divisions, and with our own workers.

Written plans and outlines of work, papers, accounts, orders, press articles, papers for presentation at meetings, and reports on various phases of our work several times each year, all these combine to form a total which requires a considerable share of the working day.

DEFINITE PROJECTS UNDER INVESTIGATION

No 1. Pecan Insects (R. W. Leiby).—Project begun in 1913.

A good knowledge of the life-history and biology of about eight species of insects more or less injurious to the pecan tree and its fruit, has been secured. A partial knowledge of a dozen more species of lesser importance is also available. Observations are supported by an extensive collection of photographs. Control measures have been tried and some found successful against the more injurious species. Limited studies were made on this project in the past three years. Project needs concentrated study over one-year period before completed.

No. 2. Larger Corn Stalk-borer (Diatraea zeacolella) (R. W. Leiby).

This project was begun in 1915, and completed in 1920, with the publication of N. C. Agricultural Department Bulletin No. 274 pp. 85, 27 figs.

The investigations into the biology of the insect led to the conclusions that: (1) corn planted after May 25 is subject to attack by the second brood of this insect only, thereby escaping injuries by the first brood, and the severity of the injuries is consequently appreciably lessened; (2) if the stubble is plowed out of the ground late in fall, climatic conditions will cause the death of 90 per cent and more of the over-wintering larvae during the winter and spring; (3) spring plowing is effective if done before May 15, this procedure destroying some larvae and preventing the emergence of moths from the stubble when it is covered with soil.

An extension circular on this insect is in the course of preparation.

No. 3. Potato Spraying and Flea-beetle Control (R. W. Leiby).

This project was begun in 1913 and has been actively prosecuted each year since. The object is to ascertain the most economical material which when sprayed or dusted will net a profitable increase in returns. Experiments have been conducted in past years on the early crop potatoes at New Bern, Wilmington, Mt. Olive, and Willard; and on the late crop potatoes at the Branch Station at Swannanoa for each of the nine past years.

In the course of the work many strengths and varieties of spray solutions have been used. The number of applications has also been varied. The experiments continue to indicate that the home-made poisoned Bordeaux mixture, applied four or five times at ten-day or two-week intervals, gives the highest returns. During the past year, however, good results have also been secured with the use of the copper-lime dust, although the net returns were not so great because of the greater expensiveness of this material.

The results of spraying experiments on late potatoes during the past nine years at Swannanoa indicate an average of 57 bushels more per acre on the sprayed than on the unsprayed. This means an average of approximately $60.00 gain per acre made by spraying the vines four or five times each season. During the season of 1922, the plat sprayed four times with the home-made poisoned Bordeaux mixture using a power sprayer but making the application by hand, yielded 286 bushels per acre; a plat similarly treated but using a traction power sprayer yielded 262 bushels per acre; while a plat dusted five times with copper-lime dust yielded 290 bushels per acre. The greatest net returns were secured from the first mentioned plat.

The following publications have been issued in connection with this project:

Extension Circular, No. 48, May, 1917.
Poster Bulletin, No. 12, March, 1918.
Extension Circular, No. 103, March, 1920.
North Carolina Agricultural Department Bulletin No. 250, March, 1919.

No. 4. Laundry Soap in Water for Aphids (F. Sherman).

For many years kerosene emulsion was the "orthodox" material to recommend for control of aphids on garden crops, flowers, etc. This material is troublesome to prepare and its accurate dilution to required strengths not easy to the less intelligent. Laundry soap is used in its preparation. In 1904 while experimenting with cabbage aphis our oil can was empty near the close of day with some plants yet untreated. Not to lose time and partly out of curiosity we treated the remained with "kerosene emulsion without the kerosene," i. e., merely soap dissolved with water but at rate of 1½ lbs. soap to 4 gallons water. Examination a few days later showed that it had been surprisingly effective. More recently nicotine-sulphate has also come into extensive use as a remedy for aphids but the general demand is so slight that few dealers in the State keep it in stock. Consequently we have from time to time tested this simple soap solution at various strengths for several species of aphids, and while we have found a dark-brown aphis on chysanthemum (species?) to be resistant—yet we have easily secured entirely satisfactory results against Cabbage aphis, Rose aphis, Black Peach aphis, Turnip aphis, a brown aphis on Virginia creeper, and others. Furthermore, we have caged treated leaves on which every living aphis was killed by the solution, and yet from parasitized dead aphids the adult insect parasites afterwards emerged! My informal comments on this simple method of control of Cabbage aphis at one of the national meetings resulted in the suggestion being incorporated into a prominent text-book of entomology.

References to soap-and-water as a remedy for aphis are not uncommon but it is seldom that specific strengths are recommended. Our purpose has been to establish a suitable strength for general use in garden crops, flowers, etc. We have for some years recommended the strength of *1 pound laundry soap to 4 gallons of water;* in our tests this has usually been effective. The method of preparation is as follows:

> Cut the soap into thin slices in one-half the quantity of water and heat to boiling, then stir to completely dissolve. Add the other half-quantity of water cold. This reduces the solution to a temperature which is not scalding to flesh or plants, yet sprays easily.

Our data on this subject is neither voluminous nor intricate, but very satisfactory to ourselves, and while many correspondents have reported good results from the use of the remedy, there have been no clear cases of failure. All of our own tests were made with the "Octagon" brand of soap, but we know of good results from other brands and also from home-made soap.

This has always been merely a minor project and has never been deemed worthy of special elaboration in publication, yet it has served an excellent purpose. I have discussed it at this length because we now regard it as closed or at least in suspension and I may not make mention of it in future reports.

No. 5. Insect Survey of North Carolina (C. S. Brimley, and workers of Division).

This permanent project is of long standing. It is intended to accumulate collections, records of occurrence and distribution (both seasonal and geographical) of all species of insects in the State whether (now) destructive or not, whether common or rare.

During the year November, 1921, to November, 1922, 235 species of insects have been added to our lists, bringing the total to 6,344.

We have constant occasion to make use of these records in our economic work, and several important cases of the kind have been mentioned in other reports. During 1922 a caterpillar, heretofore harmless, suddenly assumed enormous numbers in the central part of the State and defoliated oak trees over large area—it was at once reported to us as "new" but our survey-records showed it to be of long standing and suggested that the outbreak would be only temporary, and this proved true—thus needless fears were allayed. Also these records and collections have enabled us to report accurately upon scores of insects which have been mistaken for boll weevil and other serious pests. As a basis for first work, and for keeping our minds keen on the scope of insect problems in general, this project is of highest importance, and it is accumulating collections and records of biological and scientific value.

No. 6. Black Corn Weevil (Calandra oryzae) (T. B. Mitchell).

This species has caused unusual complaint during 1921 and 1922. While we recognize fumigation with carbon di-sulphide as the standard remedy, yet many corn-houses are too loosely constructed to permit of effective fumigation, and in this project we hope to determine some of the field conditions bearing on the pest; such as time of planting, time and method of harvesting, quick disposal, etc. Pressure of more acute issue has submerged this project to a large degree but work on it is again under way.

No. 7. Cabbage and Collard Dusting for Worms (R. W. Leiby).

This project was begun in 1917 and continued until 1920. The object was to ascertain an economical poison dust that would kill worms on

cabbage and collards, and how often it was necessary to apply the poison.

Six extensive experiments were conducted in 1917 and 1918 at Raleigh and in 1917, 1918, 1919, and 1920 at Swannanoa. The investigations show that the injuries of the worms can be profitably controlled by dusting every ten days with a mixture at rate of one pound of lead arsenate and six pounds of air-slacked lime, the same to be dusted preferably while the plants are moist.

An extension circular covering this project is in the course of preparation.

No. 8. Green Clover Worm (F. Sherman and R. W. Leiby).

This insect was epidemic in 1919, at which time we made intensive studies which are shown in Extension Circular 105. Were the insect to be regularly destructive there are certain biological points which we would still like to work out—but as it has been inconspicuous since 1919, we may now regard this project closed.

No. 9. Army Worms (2 species) (F. Sherman and R. W. Leiby).

As there have been no fresh outbreaks, active work on this project is necessarily under suspension for the present.

No. 10. Mosquitoes and Control (R. W. Leiby and workers of Division).

During and immediately following the war period there was unusual interest in this subject, hence we took it up as a "project." At once the records of our insect-survey project were taken as a basis. By arrangement Dr. H. P. Barrett of Charlotte did some special work and submitted records and data. The control-work of the Public Health Service at Wilmington and near Camp Polk at Raleigh was studied and, by permission, photographs taken. A summary of our findings was published in Journal Elisha Mitchell Society, September 1920, "Notes on the Mosquito Fauna of North Carolina" by F. Sherman, in which data is given on the 32 species of mosquitoes then on record for the State.

No. 11. Cutworms (C. S. Brimley).

The work on this project has revealed the identity of the most injurious species, their habits and general biology. Some tests have been made with poison baits, and records have been made of catches of the adult moths with bait-traps. We have also ascertained the pupating period of most of the species, thus showing the seasons at which intensive cultivation would most interfere with the development of the insects.

No. 12. Cotton Boll Weevil (F. Sherman, W. B. Mabee).

While we have followed the lead of other workers of longer experience in the application of remedial measures it has been necessary

for us to determine certain facts for ourselves, as applying to North Carolina. Our chief findings in our southern counties have been:

(1) Weevils began to appear in fields in late May and were abundant by June 10.

(2) There was a scarcity of adults around June 24 to 28, this representing the gap between the overwintering weevils and their progeny; dating back from this time we conclude that virtually all weevils were out of hibernation and in the fields by June 10 to 20. This has a bearing on the application of the recently-announced "Florida method" for control.

(3) The puncturing of squares reached the "dusting point" of 10 per cent around July 25 to 27, with much variation, some fields later than others, but average as dates given.

(4) The dust-poison method as described in U. S. D. A. Farmers Bulletin 1262, followed closely in tests on 6 farms gave an *average* increase of 328 pounds seed cotton per acre (reported further under "Extension").

(5) In its migration for 1922 the boll weevil completed the invasion of our entire cotton area, with the possible single exception of the county of Currituck.

(6) Two species of true insect parasites of boll weevil were reared in Anson county, one of which was found to kill 13 per cent of the weevils in fallen squares in one field.

This project was carried on by Mr. Haber until his resignation March also No. 124. Other matter is being prepared.

No. 13. Household Insects (V. R. Haber).

This project was carried by Mr. Haber until his resignation March 1st, 1922, since which time it has been in suspension. A considerable volume of notes and data were accumulated, and successful tests were given in the cleaning and fumigation of restaurants, stores, residences, etc., to control roaches, bed-bugs and other pests.

No. 14. Peach and Plum Curculio (R. W. Leiby).

Observations on the injuries of this insect on peaches have been made sporadically during the past ten years. In 1922 this Division in coöperation with the Federal Bureau of Entomology established a laboratory in the Sandhills of this State at Aberdeen with the object of (1) investigating the life-history of this insect on peaches; (2) conducting field experiments in its control by dusting and spraying, and the carrying out of other orchard control operations; and (3) instructing peach growers in the methods of control.

The investigations showed among other things that the insect was two brooded, a habit suspected but not heretofore demonstrated, and that it was consequently advisable to pick up all dropped fruit during

the growing season. The field control investigations were extensive, consisting of seven plats of approximately 100 trees each. These investigations were made on our two most important commercial varieties of peaches. Plats of trees sprayed four times, according to the recommended schedule, and with the dropped fruit regularly picked up, showed only six per cent of the harvested fruit wormy while the untreated plat showed 38 per cent worminess. A total of 35,621 dropped and harvested fruits was examined in securing the field control data.

A bulletin embodying the life-history studies and the field control investigations is nearly completed. This project will be continued another year.

No. 15. Fall Canker-worm (F. Sherman).

Local outbreaks of this insect in our mountain forests began in 1917 and continued through 1920. Studies were made in 1920, and have been reviewed in previous reports. The insects were less numerous in 1921, but in that year two small sendings of the European Climbing Ground-beetle (*Calosoma sycophanta*) were received from the U. S. Bureau, Entomology Laboratory at Melrose Highlands, Mass., and these were liberated in an infested area on Grandfather Mountain.

During 1922 our only part in this project was a brief visit to the area on Grandfather Mountain on July 25. We learned that the worms had not been noticeable this year, and our search did not result in finding any of the introduced beetles. This search should, however, have been made earlier in the season. We cannot yet conclude whether the introduced enemy of the canker-worms has survived.

No. 16. Control of Peach Borer (R. W Leiby).

Studies in the control of the peach tree borer by the use of Paradichlorobenzine were begun in the fall of 1921. The object was to ascertain the length of exposure necessary to "gas" this insect, the amount of material required per tree, and the minimum age of the tree to which a killing dose for the insect could be applied without injury. Experiments have been conducted at Raleigh during 1921 and 1922. They indicate that five-year-old trees will withstand an application of ¾ ounce of the Paradichlorobenzine without injury and a high percentage of the borers will be killed by the gas given off.

Circular letters and news articles have been prepared on this subject and the information given to many peach growers.

No. 17. Parasites of Hessian Fly (R. W. Leiby).

This project was begun in 1921. The object was to examine wheat stubble and tillers for Hessian fly stages and to rear the parasites there-from if infested. Six kinds of parasites have been reared from the Hessian fly in this State to date. Several of these are known to be effective in reducing Hessian fly infestation. Studies on the biology and development of two of these parasites are under way.

No. 18. Bean Leaf-beetle (Epilachna corrupta) (Office Force).

This is an insect pest of first magnitude which became established around Birmingham, Alabama, in 1919 or 1920, and has since spread rapidly. In 1921 it invaded the counties of Cherokee and Clay. In 1922 our scouting work (by T. B. Mitchell and W. B. Mabee) showed it in the additional counties of Swain, Macon, Jackson, Transylvania and Henderson. Letters plainly indicate its presence in Graham. Hence we now know of eight counties which are invaded. Reports leave no doubt as to its seriousness. We are hoping to be able to establish a field station for the study of this pest during 1923.

Finally, in concluding this report I must, as usual, acknowledge the support and encouragement at all times given by yourself as Director, and the loyal workers of this Division. We have had a strenuous year: the boll-weevil issue bids fair to make 1923 yet more strenuous, and the bean beetle is looming in our western horizon! We hope for the opportunity to increase our investigational activities to keep pace with the urgency of the problems. We have the foundations to work upon; we know what the problems are.

Respectfully submitted,

FRANKLIN SHERMAN,
Chief, Division of Entomology.

REPORT OF THE ENTOMOLOGIST

To the Director:—I have the honor of transmitting a brief report of the Division of Entomology, College Station, for the past year. Practically all of the time of the Entomologist is devoted to five projects, as follows:

No. 2. *Biology of the Genus Diabrotica (Corn Root Worm and Melon Beetle).*

No. 3. *Biology of the Genus Bruchus (Bean and Pea Weevil).*

No. 4. *Tobacco Flea Beetle.*

No. 5. *Biology of the Homoptera (Leafhoppers).*

No. 6. *Corn Ear Worm.*

A summary of the principal results on each of these projects is given below.

No. 2. Work on the safe date for planting corn to escape the attacks of the corn root worm has been continued at the Wenona and Willard Branch Stations only. Work is in progress on a detailed study of the life history of the corn root worm. Experiments have been begun to determine whether a soil repellent can be secured to use against this pest.

No. 3. The life histories of these pests have been continued. Studies of two common parasites have been made and a study of the physiological effects of lime has been begun.

No. 4. Work on this project has been discontinued temporarily for lack of funds.

No. 5. The work of indexing the literature of the leafhoppers of the world has been continued. The bibliography has been completed and is ready for publication. A scientific review of the planthoppers of Eastern North America is ready for publication. A key to the planthoppers is in press. These preliminary studies are absolutely essential to the economic work which is in progress. A beginning has just been made of the physiological effects of the bites of various leafhoppers and planthoppers on common grains and grasses.

No. 6. Continued work on the relation between the date of planting and varieties of corn on the amount of damage caused by the corn ear worm has been continued.

Respectfully submitted,

Z. P. METCALF,
Entomologist.

REPORT OF DIVISION OF HORTICULTURE

To the Director:—I herewith submit the report of the experimental work of the Division of Horticulture for the past year.

The experimental work of the Division is being continued along the lines of the projects described in previous reports.

During the year, considerable attention has been given to a more thorough direction and organization of the work. The organization of investigation so that direct attention to problems of outstanding importance may be developed has been borne in mind. Every attempt is being made to develop a program of work which will contain live projects definitely adapted to the fundamental and special problems of the State. The projects are being organized so that problems of first importance will be selected and so that the expenditure of funds and energy on problems of only local application will be limited. Every project is reviewed each year with a critical attitude to see if it is fulfilling the purpose for which it was intended.

In general, satisfactory progress should be reported in the experimental work with apples, peaches, pecans, sweet potatoes and Irish potatoes. Certain specific projects were discontinued temporarily because of the lack of funds to properly conduct them. Unfavorable weather in Spring interfered with some of the fruit investigations.

PRUNING APPLES

The training and pruning experiment with apples being conducted at the Mountain Station is one of the outstanding pieces of work of the Division. This is one of the most comprehensive pruning investigations being conducted by any station. The press of the western part of the State has published an account of the work during the last two years with the result that fruit growers are following it with much interest. In addition to being an investigation, this work is a valuable demonstration of different systems of training and pruning. The results so far secured indicate that growers have been pruning too severely, thereby causing a reduction in fruit production.

PECAN VARIETIES

The work with pecans further proved the value of the Schley, Stuart, Alley and Success varieties for Eastern North Carolina. Additional proof of the value of the Coastal Plain Section for pecan production was secured. The importance of cultivation of pecans during dry weather was further emphasized.

SWEET POTATO INVESTIGATIONS

A very successful season was experienced with sweet potato investigations at the Pender Farm. The work was of particular practical value this year because the growth of the commercial industry made an unprecedented demand for information furnished by the investigations. The project included cultural practices, varieties, storage, seed selection and handling.

The Irish potato work has again proved the value of the Rural New Yorker group for production and storage in Western North Carolina. The important work of developing seed strains in Western North Carolina for Eastern Carolina is being conducted vigorously. If this project works out a method whereby superior seed can be produced for use in the Coastal Plain, a large seed potato industry can be developed in the western part of the State which would prove of mutual advantage to each section.

J. M. Dyer, Assistant Horticulturist, resigned to enter horticultural work in Arkansas. He was succeeded by Mr. E. D. Bowditch.

With the development of many new horticultural industries in North Carolina and with future progress in established industries there is an increasing number of problems for investigation. To adequately cover the investigational field presented by the increase of horticultural industries it will be necessary for the Division to receive additional funds and to be provided with additional facilities to adequately conduct this work.

POMOLOGY

1. *Variety Work in Pomology* (C. D. Matthews, J. M. Dyer and E. D. Bowditch).

Notes and observations, on the behavior of varieties of fruits in the different sections of the State, are made from year to year. These notes and observations show the range of adaptability of the varieties in different sections.

Much time and care is expended each year in writing, revising and checking descriptions of almost all of the important varieties of fruit grown in the State. These descriptions are to be used in future publications, and are employed by the Division as an aid in identifying varieties of fruit sent to the office from over the State.

2. *Native Fruits of North Carolina* (C. D. Matthews).

The place of origin, the history, and the description of a number of varieties of North Carolina origin have been secured. When opportunity offered, the descriptions of varieties secured previous to this season were verified. Paintings and photographs have been made of the most important varieties.

3. *Peach Investigations* (Mountain Station, Edgecombe Station, Piedmont Station, Coastal Plain Station. C. D. Matthews, J. M. Dyer, and E. D. Bowditch).

(a) *"Dehorning" Peach Trees.*—No active work done on this project during the year.

(b) *Peach Breeding.*—It is the object of this project to produce improved commercial varieties that are more suited to North Carolina conditions than are the present varieties. It is the purpose to produce varieties hardier in bud than the present commercial sorts.

To provide working material for this project, a variety orchard containing over 60 different varieties of peaches was planted at the Coastal Plain Station during 1917. These trees have made a very satisfactory growth since being planted. During the last year nearly all varieties had a partial crop and some very valuable preliminary work was done in regard to collecting data concerning the characteristics of the different varieties. There is a good set of fruit buds on the trees, and active work is to be done on this project during the following year.

(c) *Hardiness of Peach Varieties in Western North Carolina.* Twenty varieties of peaches, comprising varieties adapted both to extreme northern and to southern conditions were planted at the Mountain Station in the spring of 1919 to furnish material for work on determining the relative hardiness of different peach varieties in Western North Carolina. These trees have made a very satisfactory growth since being planted.

(d) *Phenological Studies with Peaches.*—The practice of collecting phenological notes on the peach varieties in the varietal peach orchard at the Truck Station was started during the spring of 1920. These notes will be of immense value in handling the breeding project.

(e) *Variety Testing with Peaches.*—No active work was done on this project because the crop at the Truck Station was killed by late spring frosts.

4. *Pecan Investigations* (Coastal Plain Station, Edgecombe Station, and Piedmont Station. C. D. Matthews, J. M. Dyer and E. D. Bowditch).

(a) *Variety Testing.*—Thirty-two of the most important southern varieties are included in this test which has been conducted for 15 years. Gratifying results are being secured from this work, as certain varieties are showing marked adaptability to North Carolina conditions while others are proving to be undesirable. At this time, valuable recommendations regarding pecan varieties for planting in this State can be made. According to the results secured, the Schley,

Stuart and Alley varieties are most desirable for Eastern North Carolina.

(b) *Individual Tree Performance.*—The securing of performance records of the individual pecan trees in the experimental orchards at the several stations is being continued from year to year. Such a record affords a more detailed study of the behavior of the different varieties. As a result of the individual tree performance records, it has been noted that trees of the same variety under identical conditions are uniformly heavy yielders, while others are very poor producers, that some produce uniformly large nuts and others uniformly small nuts. As these individual performance records suggest the possibility of improving and standardizing individual yields by bud selection, work has been started along this line.

(c) *Cultural Practices.*—The value of correct cultural practices, such as tillage and the use of cover crops, is clearly shown in the increased size of trees and in the increased size and number of nuts produced when compared to trees and their products grown in sod. To determine the most desirable system of tillage and cover cropping to be employed in pecan orchards, work of this nature is being conducted at the Branch Stations.

(d) *Pecan Breeding.*—The seedlings, as a result of pecan breeding work, that were set in 1915 at the Truck Station, are making a satisfactory growth. Some of these seedlings are of bearing size and should produce some nuts during the coming year.

(e) *Top-working Pecan Trees.*—The investigations dealing with the methods of budding and grafting employed in top-working pecan trees was continued this year. It has been found that a combination of both grafting and budding should be used to secure the most satisfactory results. As a result of years of investigation, it is the opinion of this Division that top-working should be confined, as a general rule, to trees not over 8 to 10 years old, to be entirely successful.

(f) *Cracking Tests with Pecan Varieties.*—The cracking test of the different varieties is made each year. The cracking test is a necessary adjunct to the performance record of a given variety in determining its value in a certain section. Very often a variety is highly satisfactory from a productive standpoint, but the cracking test shows it to be nearly worthless from a utility viewpoint. The cracking test shows the number of nuts per pound and determines the per cent of unbroken halves the variety will crack out, the per cent of shrunken kernels, the per cent of physiological spot, the per cent of faulty nuts, and shape and size of the kernels, the texture, quality and flavor of meat, the per cent of meat and the thickness of shell. As a result of these cracking tests conducted each year, certain varieties that were

satisfactory from a productive standpoint proved to be totally unsuited to North Carolina conditions.

5. *Strawberry Studies* (Coastal Plain Station—C. D. Matthews and L. H. Nelson).

(a) *Variety Testing.* This project was discontinued temporarily because of lack of funds. The variety testing project with strawberries was initiated several years ago with the purpose of determining whether or not there were any other varieties more desirable as commercial market varieties than Klondike and Missionary, the two leading commercial varieties. For this State the most profitable berry combines the characteristics of productiveness, earliness, and shipping quality. None of the varieties so far tested have shown themselves superior to Klondike and Missionary as commercial varieties. Several of the varieties have shown themselves valuable for home use.

(b) *Cultural Practices.*—During the year, experiments to determine the most desirable planting dates were conducted as well as work to determine the value of removing blossoms and cutting runners. This project has not been in operation a sufficient length of time to furnish any conclusive information.

6. *Apple Investigations*—(C. D. Matthews, J. M. Dyer and E. D. Bowditch—Mountain Station, Piedmont Station and Coastal Plain Station).

(a) *Pruning* (Mountain Station).—The pruning project was begun during 1919, with the intention of securing information on the desirable height to head apple trees, to determine the comparative value of the open head and the modified leader system of training, and to secure information on the amount of annual pruning most desirable. To supply material for this work, an orchard containing approximately 128 trees was planted at the Mountain Station in the spring of 1919. The trees have made a very satisfactory growth and the first and second year's work has been completed as planned.

(b) *Thinning.*—(Mountain Station and Piedmont Station).

Experiments to determine the effect of thinning fruits and leaves from the fruit spurs of the apple were initiated. Work on this project has not been conducted a sufficient length of time to supply information on the subject.

(c) *Summer Apples* (Coastal Plain Station).—The summer apple orchard at the Truck Station did not produce a crop this season because of frost injury.

VEGETABLE CULTURE

1. *Sweet Potato Investigations* (Coastal Plain Station—C. D. Matthews and L. H. Nelson).

(a) *Variety Testing.*—It is the purpose of this work to determine the most desirable varieties of sweet potatoes for Eastern North Caro-

lina from the standpoint of productivity, market value, keeping quality and quality. There were 29 varieties under observation this year. The results were, in the main, confirmatory of the work of previous seasons. Certain varieties have proven their desirability while others have shown themselves to be undesirable.

(b) *Storage.*—In connection with the variety work, storage tests are being made from year to year in the storage house to determine the behavior of the different varieties in storage. Certain varieties have proven themselves to be better keepers than others.

To facilitate the storage investigational work, an additional curing room was constructed during the summer.

Investigations to determine the relation of time of digging to keeping quality, the relation of proper harvesting to keeping quality, the proper method of curing, and the correct management of the house, have been continued this season.

As a result of this work, the Division can authoritatively make recommendations regarding varieties for storage and the most desirable methods to employ in the management of the storage house.

(c) *Cultural Practices.*—During the year, work was conducted to secure information on the following different cultural practices:

(1) The comparative value of slips vs. vine cuttings as regards productivity.

(2) The effect of ridging on productivity and type of potatoes.

(3) The effect of vine cuttings on yield.

(d) *Seed Selection.*—The following lines of work dealing with the seed selection of sweet potatoes were conducted during the year:

(1) To determine the relative value of seed stock from high yielding and low yielding hills as regards productivity and uniformity of potatoes.

(2) To determine the relative value of vine cuttings as compared with slips for maintaining yield and type, commencing from the same hill.

(3) To determine the comparative value of large and small potatoes for seed.

(4) To determine the comparative value of seed from late vine cuttings and seed from main crop draws as regards productivity, type, and keeping quality.

Very satisfactory progress should be reported on this project for this year.

2. *Irish Potato Investigations* (Mountain Station and Coastal Plain Staton—C. D. Matthews, L. H. Nelson and S. C. Clapp).

(a) *Variety Testing* (Mountain Station).—The testing of varieties of Irish potatoes to determine the most desirable varieties for Western

North Carolina conditions was continued this year with 20 varieties. The testing has been in progress for a sufficient length of time to afford this Division the necessary information to make reliable recommendations regarding the choice of varieties for the western part of the State.

(b) *Variety Testing* (Coastal Plain Station)—Satisfactory progress should be reported on the work to determine the most desirable early varieties for Eastern North Carolina and the best varieties for the second crop.

(c) *Hill and Tuber Unit Selection Work* (Mountain Station) The hill and tuber unit selection method of variety improvement is being employed in an attempt to produce strains of the best varieties with greater productivity and more desirable characters.

(d) *Cultural Practices* (Coastal Plain Station)—Work was conducted to determine the effects of different cultural practices on the yield of potatoes. Practices receiving consideration were:

(1) Width of rows.
(2) Distance apart in the rows.
(3) Freshly cut or stored cut seed.
(4) Effect of sprouting on yield.
(5) Cut versus uncut seed.

(e) *Testing the Value of Different Sources of Seed.*—Experiments were conducted to determine the comparative value of Maine grown seed, second crop seed produced in the Coastal Plain, and Western North Carolina seed in different stages of maturity as the most desirable seed for the early crop of Irish potatoes in Eastern North Carolina.

This work has not been in existence a sufficient length of time to furnish conclusive results.

(f) *Investigation of Methods of Producing Seed Potatoes in Western North Carolina for Use in Eastern North Carolina.*—Two methods of attack are being used in this investigation—one consists in growing the seed at different elevations, while the other consists in planting the potatoes at different times in the spring and summer. In both cases it is intended to secure seed at different stages of maturity. At present results indicate that elevations over 2,500 feet will grow desirable seed for Eastern Carolina.

3. *Cabbage.* (Mountain Station—C. D. Matthews, L. H. Nelson and S. C. Clapp).

(a) *Variety Testing.*—The testing of varieties of cabbage to determine the most desirable varieties for Western North Carolina was continued this year. The testing has been in progress for a sufficient length of time to afford this Division the necessary information to make reliable recommendations regarding the choice of varieties for the western part of the State.

4. *Observation Garden.* (Coastal Plain Station—C. D. Matthews, and L. H. Nelson).

The all year observation garden at the Truck Station which has proven so valuable in the past in supplying information regarding varieties and planting dates of different vegetables for Eastern North Carolina was not continued throughout the year because of the lack of funds.

Respectfully submitted,

C. D. MATTHEWS,
Chief, Division of Horticulture.

REPORT OF HORTICULTURIST

To the Director:—Investigational work in horticulture at the State College Station for the year 1921-22 has been continued along the line of original research, the various subjects studied being as follows:

U. S. D. A. No. 12: Study of the Transmission of Characters in Hybrids of Rotundifolia Grapes. Of the six subdivisions of this investigation, Projects 4, 5, and 6, as to inheritance of sex, productivity, and color, respectively, have been more or less inactive during the year; attention having been directed toward those of inheritance of size of fruits, of qualities, and facts of hybridization with other species.

U. S. D. A. No. 23: Genetic Studies with *Juglans regia* (English walnut); including Methods of Propagation.

Search for natural hybrids has been conducted and some specimens located. Seed of some of these has been secured and arrangements have been made for wood for propagation when needed. Seeds for stocks planted last fall did not germinate well, probably due to low vitality as a result of climatic conditions which prevailed last summer and fall, and a new planting is to be made in a few days.

U. S. D. A. No. 24: Prune Types of Prunus Species.

Stock of the "Marshall" prune was secured and propagated by root-grafting last year, but only two or three plants have survived. Top-working will be resorted to in order to save time in the study of this specimen. Stock of standard prune species were not planted last winter because of inability to secure them in time.

U. S. D. A. No. 25: Genetic Studies with Bramble Fruits, especially Raspberries.

Search for "wild" stock was made and several plants of the purple-cane type were discovered and transplanted to the plot set aside for this work, along with stock of various other species secured for the purposes of the investigation. Growth this year has been good, and by another year, active work of crossing can be undertaken.

Work With Grapes

In the work with grapes as to hybridization of V. rotundifolia with other species, twenty-six combinations were attempted in 1921 and forty-nine during the present year. This involved the bagging and cross-pollination of 169 clusters in 1921 and 181 in 1922. From these, 483 seeds were recovered from bags placed in 1921 and 345 from those of the current year. This year, thirty seedlings, representing eight successful species-combinations, have been grown to size for transplanting. Seeds from crosses made this year will be stratified in a few days. The amount of rain during the blooming period last spring interfered greatly with the work of crossing, at least 150 bagged clusters not being pollinated because of rainy weather at the critical time. Stock on hand and growing at this time is as follows:

Vines in Muscadine Vineyard	57
Vines in Breeding Plot	592
Varieties of Vitis rotundifolia available	13
Varieties of Munson's "hybrids"	7
Species of Vitis (Pure stock)	16
Vinifera hybrids	58
Winchell hybrids	34
Bourquiniana hybrids	9
Labrusca hybrids	3
Cinerea hybrids	1
Aestivalis hybrids	5
Total	795

Some of the outstanding points in connection with the work of the year are as follows:

The wide variation in blooming season among the various species of Vitis is a serious handicap to the work of securing hybrids among them, and the forcing of flowers under glass has not proved sufficient to accomplish the necessary advance in time of blooming, particularly of V. rotundifolia. During the next season, an attempt will be made to utilize Garner and Allard's methods of forcing by means of a lengthening of the daily period of growth to bring about the necessary early ripening of pollen of this species.

Black rot has not been considered a serious matter with respect to V. rotundifolia since it does not affect the vines and fruits to any appreciable extent. However, it is proving to be a very serious matter since it develops that it is a very important factor in the setting of fruit, the vulnerable point with this species being the flower clusters, many of them being destroyed wholly or in part by this disease.

The anatomical characters of the stem of V. rotundifolia differ greatly from those of the species of Euvitis (*V. Labrusca, V. cordifolia, etc.*). Investigation has further proven that these characters

are more or less intermediate in the F_1 generation, with varying amounts of dominance and certain correlations. No previous work has been done on the subject of the inheritance of anatomical characters. In fact, few crosses are effected between parents of appreciable anatomical differences.

One of the possible benefits to be derived from the hybridization of V. rotundifolia with other species is that from hybrids secured, which would show more or less closely related anatomical stem characters, there may be developed a Phylloxera resistant stock on which to work V. vinifera which cannot be grafted on pure V. rotundifolia stocks. This would prove of great advantage, because of the great resistance of V. rotundifolia to this pest.

Furthermore, in view of the difference noted in the fibrovascular systems between muscadine and "bunch" grapes, there is probably a correlation between these types of vascular systems and the "cling" quality of fruit. In pursuance of this line of investigation, 89 microscopic slides have been made in the region of separation of pediccel and berry. This cytological study of V. vinifera and its hybrids is being undertaken because:

1. Most of the species crosses are hard to make.
2. The reciprocal cross with Rotundifolia as female parent is seldom if ever successful.
3. The F. generation has a tendency to be self-sterile.
4. The chromosome condition may have something to do with all the points just mentioned.

It seems, therefore, that this work is likely to prove of very great value. A review of the work already done along this line is now being made with a view to publication of some of the more important findings up to the present time.

Respectfully submitted,

J. P. Pillsbury,
Horticulturist.

REPORT OF THE DIVISION OF PLANT PATHOLOGY

To the Director:—The following statement concerns the investigational work of this Division for the fiscal year ending June 30, 1922.

Since little progress has been possible in the investigation of certain diseases of tobacco, it has been decided to prepare for publication, during the coming year, a report on the work as far as it has gone, and then to discontinue this project. This report will include the studies on tobacco wildfire. It has been found, in addition, that the organism which causes tobacco wilt and which is known to attack a number of other crop plants, as Irish potatoes, tomatoes, eggplants, peppers, peanuts and velvet beans, as well as a considerable number of common weeds, attacks also soybeans, cosmos, and dahlia. A leaf-spot disease of tobacco, *Phyllosticta nicotianae*, collected outside of North Carolina in Ohio and Florida alone, has been found both in plantbeds and in the field, but has not been observed to cause any material losses.

The work on bacterial leaf blight of soybean has, from necessity, been limited to laboratory and greenhouse studies. Consideration has been given, among other things, to its relation to an undescribed bacterial disease of clovers from which it has been found to be specifically distinct. A detailed report of this work will be published in the near future.

The rust-resistant varieties of wheat, which have been tested in cooperation with the Division of Agronomy, are not suited to North Carolina. These tests have been in progress for three years and are to be discontinued. It is evident that further work along this line will meet with success only by selection or breeding, using as stock varieties known to be adapted to culture in this State.

The work on Phoma blight of soybean was not completed during the year, as was expected, but will soon be presented for publication. Considerable data on the treatment of seed-borne infections, especially cotton anthracnose, have been secured and this work will be continued during the coming year.

The identity of certain underground structures called tuckahoes or Indian potatoes has been discovered. These structures have been known as long ago as the early settlements in America but have remained a botanical mystery.

PUBLICATIONS

The publications from the Division during the past year include the following:

1. Studies on the physiology of some plant pathogenic bacteria. Tech. Bul. N. C. Agr. Exp. Sta. 20: pp. 47, fig. 1, 1921.
2. Additional hosts for Bacterium solanacearum. Phytopath. 12: No. 2, 98-99, 1922.
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Respectfully submitted,

Frederick A. Wolf,
Plant Pathologist.

NOTEWORTHY PLANT DISEASES IN NORTH CAROLINA IN 1922

By Frederick A. Wolf

Two years ago brief mention was made in the annual report of this department, of several diseases which were not being made the subject of special study but were of more than passing interest. Subsequently, three of them have been investigated more fully here and one of them at another of the Experiment Stations. It is accordingly felt that a brief record of other diseases which have been observed during the past year will have a very definite value to all interested in plant disease problems, and so brief mention is accorded them at this time.

Cotton anthracnose associated with boll shedding

Boll shedding of cotton is known to be due to a number of causes, as heavy and continuous rains, abrupt changes in weather as cloudy to clear and cool to hot, high temperature, low soil moisture content, and imperfect pollination but no record appears to have been made previously to the cotton anthracnose fungus as a cause of this phenomenon. Specimens of young bolls, which have shed, in various stages of development up to one-quarter inch in diameter, were first sent to this laboratory by Mr. C. L. Newman, Laurinburg, N. C. Many of these bolls possess lesions on the portion of the pedicels immediately beneath the bracts. These lesions were elongated and sunken and covered with a pink fungus layer, the conidial stage, *Colletotrichum gossypii*. In other cases, the basal portions of the young bolls were invaded and discolored by this fungus. To all appearance the fungus had advanced from the pedicels upward into these boll tissues.

Edgerton (La. Agr. Exp. Sta. Bul. 137) artificially inoculated cotton flowers with anthracnose and the infection spread thence to the young bolls (see p. 45), but flower infection does not appear to occur naturally. In the present instance, it is believed that infection originated around punctures made by boll weevils and that these insects were the agents of dissemination. However, no definite proof that such is the case has been secured.

Downy mildew *(Plasmopera cubensis)*

Downy mildew of watermelons and cantaloupes has been unusually destructive throughout the State during 1922, as it brought about the death of the vines about the middle of the picking season. The weather conditions during the past summer, notably excessive rainfall and high humidity, were beyond doubt favorable for the presence of downy mildew in destructive form. During a season of normal or subnormal rainfall in North Carolina, this disease is absent or can be found only after a long search.

Strawberry leaf scorch *(Mollisia earliana)*

A little known disease called leaf scorch is present throughout the strawberry growing sections of the State. It attacks not only the leaves but the fruit pedicels as well. During the past season it caused losses, as estimated by the growers themselves, of between twenty to thirty per cent of the crop. Some idea of the enormity of these losses can be gained by recalling that approximately 1,000 carloads of berries were shipped from Eastern North Carolina.

Apparently, leaf scorch has not been sufficiently destructive in other sections to warrant experimental work on control. The problem of control is, therefore, being undertaken, since the prevention of this disease would be of great value to strawberry growers.

Stem rot *(Sclerotium Rolfsii)*

Quite a number of field and garden crops and ornamental plants as well are known to be attacked by *Sclerotium Rolfsii*. Mycological notes, listing additional hosts, have been published from time to time but no extensive study of the disease has ever been made. During the past summer, this fungus has been collected near Rockingham, N. C., on strawberries, a host upon which it has not previously been reported. It produces the characteristic type of disease known on other hosts and sclerotia are formed within the disintegrated stems.

Sclerotium stem rot (*Sclerotium Rolfsii*)

This disease has not previously been reported on tobacco in this country. Record has been found of its occurrence abroad, however, since Westerdijk observed it on seedling tobacco in Sumatra (Westerdijk, J. Sclerotium disease of tobacco, Meded. Deli-Proefstat. Medan, 10; No. 2, 30140, pls. 2, 1916). During the past summer this disease has been collected on mature plants from the vicinity of Wilson and New Bern, N. C. The portions of the plants at or near the ground level were involved in decay and sclerotia were present on the lesions.

Nematode galls *(Tylenchus tritici)*

During the season of 1921, a serious disease of wheat caused by nematodes was found for the first time in North Carolina in Wilkes County and, during the present summer, it has been noted in Haywood County. This disease was introduced from Europe and has been known in the United States since 1909. Snbsequently, it has been found at many points in Virginia and a few in California. The destructive nature of this disease calls for vigorous efforts to prevent its further spread and to stamp it out in localities already infested.

Leafblight *(Cylindrosporium juglandis)*

Specimens of this disease on walnuts were sent to the writer by a correspondent from Edenton, N. C. This disease which was first collected in Alabama in 1912 (Wolf, F. A. A leaf disease of walnuts. Mycol. Centrb. 4:65-69, 1914) is of interest since no other collections have been made in the Eastern United States and since in the Western United States it occurs quite commonly on black walnuts, as learned by letters from Mr. C. O. Smith, Plant Pathologist, Riverside, California.

REPORT OF THE DIVISION OF MARKETS AND RURAL ORGANIZATIONS

To the Director:—This report is for the crop year ending December 1, 1922, and covers the investigational work of the Division of Markets and Rural Organization of the Agricultural Experiment Station, in coöperation with the United States Department of Agriculture under the agreements and plans entered into by these institutions for the conduct of all agricultural work of this kind in the State.

STATE WAREHOUSE SYSTEM

The State Warehouse System has undergone considerable development instant to the progress of coöperative marketing. The system has grown from thirty-two warehouses last year, having an aggregate capacity of 49,050 bales, to seventy-eight warehouses having a total capacity of 212,620 bales.

Of course, this growth has meant considerable expansion of the force handling the State Warehouse System; this force having now been increased to one bookkeeper, three clerks in charge of insurance records, one stenographer and three clerks in charge of files and signing of receipts. These employees are in addition to the State Warehouse Superintendent.

The State Warehouse Superintendent's office not only exercises a very direct supervision of the operation of the warehouses, making constant checks of their affairs, but the office also carries and issues from time to time all supplies in the way of receipts, tags and report forms.

All cotton stored in State Warehouses is insured by the State Warehouse Superintendent, this insurance being figured from this office and carried in such manner as to effect very large savings in cost of insurance to the people of the State.

During the past five months the office has been directed by J. M. Workman, who has been acting as State Warehouse Superintendent in the absence of B. F. Brown, the duly elected Superintendent, who, with the permission of the Board of Agriculture, has been devoting his attention to the Coöperative Marketing Association for a limited time.

COTTON CLASSING

P. H. Hart, Specialist in Cotton Classing, reports that during the season September, 1921, to September, 1922, the number of bales of cotton classed by our offices was as follows:

Fayetteville	5,468 bales
New Bern	8,883 bales
Wadesboro	7,911 bales
Greenville	3,309 bales
Winsdor (Closed Feb. 1, 1921)	3,150 bales
Raleigh	7,236 bales

There was little demand for cotton classing offices for the 1922-23 season because of the organization of the Coöperative Marketing Association with its 30,000 members in North Carolina. Only two offices, therefore, have been operating outside of Raleigh. The New Bern office, from September to December 1st, has classed 2,709 bales and the Fayetteville office, 9,348 bales for the same period.

Through a coöperative arrangement, the Cotton Association is now furnishing ideal quarters for the classing work and all cotton samples submitted, regardless of whether the owners are members of the Association, are classed in the same room by the same classers. At present there are eight classers and five helpers busily engaged in this work, but five of these classers are engaged for only the rush season. During September, October, and November a total of 74,000 bales have been classed for the Association and 5,872 for non-members. This makes a total of 114,638 bales classed during the past fiscal year, December 1, 1921, to December 1, 1922.

WAREHOUSE CONSTRUCTION

During 1921, the numerous inquires received from all over the State indicated that interest in cotton warehouse development was active even though construction projects were held back by reason of financial stringency and later rise in the price of cotton. By reason of this situation and the merely formative stage of the Marketing Association, the services of our engineer, J. M. Workman, were directed largely toward a survey of the State aimed to determine the actual and relative advantages of 300 towns as marketing and storage centers for cotton. This study is designed as a guide to the marketing association and to the most intelligent application of the State aid and loan funds. It takes into consideration existing trade connections, variety and density of cotton production and its distribution, highways and transportation facilities, financial institutions, and fire protection ratings. It is recognized that development in intelligent and truly economical production must reinforce all marketing accomplishments.

The two warehouses that were constructed in 1921 were at Kings Mountain and Dunn. They had an aggregate capacity of 110,000 bales.

Both were constructed with the aid of the State loans and in accordance with plans engineered by the Division of Markets.

During the past year there has been an increase in the interest evidenced in the cotton storage business and a number of warehouses have been constructed. The warehouse department engineer has furnished plans for the construction of warehouses at Goldsboro, Norlina, Fayetteville, and Raeford, having an aggregate capacity of 26,000 bales. These warehouses are now nearing completion.

The work of supplying engineering services has been conducted by J. M. Workman, Warehouse Engineer, who has also concluded the preparation of the economic storage survey designed to determine the most economical development of storage facilities in the State. This work, however, has been carried on to a lesser degree by reason of the fact that the past five months Mr. Workman has been serving as State Warehouse Superintendent.

WAREHOUSE ORGANIZATION

T. B. Parker has had charge of the organization work in connection with warehouse construction. On account of financial conditions the year 1921 was one of little activity in warehouse work. The past year has seen improved conditions but the uncertainty as to the steps the Cotton Growers' Coöperative Association would take in regard to cotton storage warehouses held the work in abeyance for a considerable time.

During 1922, Mr. Parker has visited a number of places in the interest of improved warehousing facilities. Among these are the following: Nashville, Whitakers, Conetoe, Benson, Norlina, Warrenton, Warren Plains, Raeford, Stantonsburg, China Grove, Salisbury, Kelford, Scotland Neck, Mount Olive, Goldsboro, Kinston, Greenville, Farmville, Macclesfield, Pinetops, Cleveland and Seaboard. He was called to Tryon, where steps were taken to get into coöperative dairying; to Pittsboro, Rutherfordton, Elm City and Poplar Grove and also appeared on the program at the District County Agents Conference at Wilmington and Statesville.

LIVESTOCK

Because we have been without the services of a Specialist in Marketing Live Stock, the report on this phase of our work is limited to the period since V. W. Lewis has been connected with the Division. There are so many projects in livestock work deserving immediate attention that it is impossible for the one specialist to take care of the needs properly.

After the war the obligations the farmers had to meet caused many herds and flocks to be sacrificed. In many cases the younger animals

were sold on the market in preference to older ones because they would bring more money. Later the older animals were forced on the market because they were no longer fit for breeding purposes.

This deflation in prices and depletion of good breeding herds has to some extent reacted, causing the price of market animals during the past year to advance, as will be shown from comparison of prices quoted from "Livestock Markets":

	Oct. 23, 1922	Oct. 24, 1921	Per cent Advance
Top Steers	$13.55	$ 8.60	41.1
Top Yearlings	12.00	11.25	15.5
Feeder Cattle	8.00	6.75	18.5
Top Hogs	9.75	8.30	17.4
Top Lambs	14.60	8.75	66.8
Feeder Lambs	14.75	7.75	90.3

Hogs

A year ago we found that very little coöperative marketing of hogs had been done for the past two years. In fact only Iredell County had shipped any hogs in this manner during that time.

The Office of Swine Extension was getting some excellent feeding demonstrations, going in a few counties over the State and since these demonstrations could be made the basis of making up coöperative carload shipments we gave assistance whenever possible in encouraging this work and handling these coöperative shipments.

This work has grown during the year so that thirteen counties produced and sold coöperatively 33 cars of hogs fed under the direction of the Office of Swine Extension and sold through this office. Most of this work has been done in the eastern part of the State in cotton growing sections, and no doubt the invasion of the boll weevil has had considerable to do in preparing the minds of the farmers in this section for this hog work.

Most southern farmers who produce surplus hogs for the market sell these hogs during the months of November, December and January. Our plans have been to get North Carolina farmers interested in selling their surplus hogs on the high markets.

Most of the shipments, made in the spring of 1922, were sold during the month of March. Summer shipments were made during the months of June, July and August, most of them going to Richmond, Va., where they brought 10½ to 11¾ cents per pound. In many instances the carload shipments were sold for 9½ to 11 cents per pound f. o. b. shipping point.

In marketing the hogs of these sales it has been our purpose to develop as much as possible the local markets within the State. In this we have been rather successful in that we have sold a number of cars

of these hogs to Hooker & Co., Kinston, and the Charlotte Packing Co., Charlotte.

The hogs fed and marketed under the instructions furnished through the Agricultural Extension Service have been of such good quality and finish that we have been able to receive top prices for these hogs. We hope to develop this work to the extent that we will be able to get a very large part of the surplus hogs of the State of such quality and finish that they will sell as well as Corn Belt fed hogs and if the farmers can be taught to get their hogs on the market at the right time, there is no reason why the hog industry in North Carolina should not grow and be developed on a very profitable basis. Charts which have been prepared by this office show that over a twenty-year period the lowest prices are in November, December and January, when the bulk of the surplus hogs in North Carolina are sold.

Lambs

In view of the fact that lambs sold for a much better price than was anticipated, farmers were encouraged to sell their early lambs on local markets where they were receiving 15 to 20 cents per pound gross weight rather than wait until later when the coöperative shipments would be ready with a chance of taking less money. These prices were very satisfactory to the producers and it enabled them to sell their lambs when of the right weight rather than selling them when the smaller ones were ready.

It is interesting to know that spring lambs sold on the Chicago market at a price (26c per pound) higher than at any time during the war, the highest price being at this time 25 cents per pound gross. This price for mutton, together with the splendid price received for wool during the year, is causing a greater development of the sheep industry in the State.

Wool

Wool could hardly be sold for any price in 1921. During the winter prices began to advance. As usual the local wool buyers received the information before the farmers had it and contracted for a large part of the wool before the farmers were aware of the advance in price. To assist the farmers in getting better prices than offered by these local wool buyers, arrangements were made for a number of wool pools in this State, making the county the unit. Three hundred and one farmers consigned 43,789 pounds of wool and received an average price of $0.309 per pound.

We were assisted in grading the wool by a representative of the Bureau of Agricultural Economics, Washington, D. C. A considerable number of buyers were interested in these sales but a large part of the

wool was bought by the Chatham Manufacturing Co., Winston-Salem, N. C.

Very few counties in Western North Carolina were active in this plan. The wool pool held in Jackson County, also the ones held in Avery and Watauga Counties were independent of the ones just mentioned and approximately 20,000 pounds of wool was sold for 36c per pound, which was five to eight cents per pound more than the farmers were offered at the time of the sale.

Our plans are to continue the wool marketing project for 1923 in the same manner as this year, and the indications are that we will have no trouble in getting a much larger amount of wool consigned.

Cattle

There has been little interest in feeding cattle in this State during the past two years as a result of the high prices of feed. It seems that the winter of 1922 would be a better time for feeding cattle, due to the fact that the price of feed and the price of cattle are more in line, but the farmers have manifested very little interest in feeding cattle this season.

Arrangements were made for holding a coöperative cattle sale at Spruce Pine to include the Counties of Yancey, Mitchell and Avery. Nearly 300 head of cattle were consigned and sold at auction to the highest bidder at very satisfactory prices. This is the second coöperative sale held at this point. The first one was held in September, 1920.

Unfortunately, the better class of cattle in these three counties was contracted for before it was decided to hold a co-operative sale this season. Our plans are to continue the coöperative sale project another year, as the farmers were very much pleased with the results received.

We have made a number of shipments of cattle to Richmond and Baltimore markets this past season.

Cheese

North Carolina is producing annually around 400,000 pounds of cheese. This cheese is produced in Western North Carolina in a section where the roads are in bad condition, thereby making market facilities very poor. Practically all the output of these cheese factories in the State since they were established has gone to Swift & Co., and Armour & Co., the prices being based on the lowest Plymouth (Wis.) prices.

The producers furnishing the milk for these cheese factories have felt for some time that they were not receiving enough for it. An effort has been made by this Division to help create a market in North Carolina and adjoining States for North Carolina cheese. Through reliable brokerage firms considerable of this output has been distributed direct to wholesale grocers who are glad to buy North Carolina cheese.

In this way the price per pound received for the output of cheese in North Carolina has been increased.

The great trouble with this particular industry at present has been that no storage facilities have been provided and during the time when most of the output is being made during the summer months it is forced on the market at a time when cheese is lowest in price for the year.

Eggs

In the spring of 1922 an effort was made to assist in marketing eggs. It was soon found that the supply was much less than the demand for good eggs and that it was impossible to satisfactorily market poor eggs in this State.

What is badly needed in regard to this industry is that the amount furnished the market be properly candled and graded before being put on the market. There is a splendid market for more eggs than are produced in this State when this is done.

Farm Fencing Campaign

In view of the fact that Eastern North Carolina is to change its methods of farming, using considerable areas of land now devoted to cotton in producing foods and feed crops (and necessarily more live-stock), it is very essential that this section of the State build more pastures and do more fencing.

Arrangements are being made with the various hardware dealers in those counties who sell products of the American Steel and Wire Company, New York, to sell farm fencing material at cost to the farmers plus 5% for handling through the dealer.

In this plan the farmers are to pay cash and to receive shipments from the car.

FRUITS AND VEGETABLES

Organization

The past year has found the fruit and truck growers unusually eager to coöperate with each other. This has been especially true since the passage of the recent coöperative Marketing Act, as it is now possible to perfect an organization that will be able to weather hardships. The former Act permitted no really binding features, and most of the old associations that were able to survive have been reincorporated in order to gain the advantage of the recent Act. In this transformation they were assisted by Mr. Gorrell Shumaker, who is handling the marketing of fruits and vegetables.

The greatest activity has been among the sweet potato growers. Here the Division of Markets has worked in close coöperation with

the Division of Horticulture. Over a dozen local sweet potato growers associations with their subsidiary storage corporations have been formed. Several of these have then been welded into a State Federation, which has for sale this year around 70,000 bushels of potatoes. About a dozen complicated legal forms, including by-laws, contracts, and various forms of agreement, have been prepared as a standard for use by these organizations. In the preparation of these we have had the assistance of Aaron Sapiro.

Considerable attention has been devoted to local marketing problems. An attempt was made to assist the Farm Agent and Home Agent in starting a city market at Charlotte, but the venture has not yet materialized because of so little local support. The coöperative marketing stall in the Durham market and the curb markets at Greensboro, Fayetteville, and Lumberton have been successful. A circular entitled "Market Requirements for Fruits and Vegetables" was prepared for use on these local markets. The latest development is the coöperative stall in the Raleigh Market. Several days were spent in assisting with the planning of this venture and the neat arrangement of its products, together with aid in standardizing grades for the various commodities. A study is now being made of the situation at Oxford with a view of making recommendations for the improvement of local marketing conditions there.

Market News Service

The coöperative arrangement between this Division and the Federal Bureau of Agricultural Economics for handling market news service has been continued. Under this plan the Division of Markets usually bears most of the local expense and the Washington office provides for collecting the information on the consuming markets. During the shipping seasons strawberry reports were mailed from Chadbourn, potato reports from Chadbourn and peach reports from Aberdeen. Melons should by all means be added to this list if sufficient funds are available.

Standardization of Grades

Growers everywhere are endorsing the standardization program. More calls for grading demonstrations are received than can be cared for with the limited force at hand. The strawberry and sweet potato grades remain unchanged and only slight changes have been made in the official grades for potatoes and apples. Beginning with the coming season there will be official grades for cucumbers and peaches, as the two years of experimental work with these grades among our growers have met with so much favor among both the trade and producers. Grades will be recommended for other commodities as fast as time can be spared from the present projects for the investigational work necessary.

AGRICULTURAL STATISTICS

Crop Reporting Service

This work is showing the most complete results of any period in its existence. It embraces, in addition to the original crop estimates program, statistical work in research, an annual farm census of considerable possibilities, a well-developed tobacco sales reporting system, and it now proposes to function in a more effective way by extending agricultural economics data and interpretations to the State College of Agriculture and to the Extension Service workers. More effective publication of its findings and efficiency in methods of determining its results have been gained. The results are being accepted as authentic and the farmers and the public generally are supporting the work and using the information to advantage.

Mr. Frank Parker, Agricultural Statistician, reports that incomplete records for the year indicate that 4,692 letters and 28,967 reports were received through the mails. At the same time they mailed out 4,295 letters and 114,082 reports and schedules in addition to thousands of circular letters and pieces of printed matter.

Publications

By resuming the publication of the Farm Forecaster as a medium of disseminating statistical information and reports, it has been possible to meet the many calls for facts which could not have been supplied through individual letters, as was necessary last year. State College and agricultural high school students are increasing their use of these publications to a surprising degree. In many instances County School Superintendents have had their teachers make use of the crop reports.

Farm Census

Considerable recognition is due to the farm census which was begun as a voluntary survey, by counties, and which is now an established part of the tax listers' work. By intensive efforts this year the work will be completed months ahead of the usual time, despite the increased scope of the work. Besides the usual crops there have been included: tenant and idle land studies, fertilizers, fruit, pasture, legumes, truck, bees and other economic facts. Reports have been secured on 185,000 farm tracts, each report covering 34 basic items of information. The results should be of great value to Extension workers and agricultural interests generally.

CREDIT UNIONS

Like all other organizations or institutions dealing with finance, the Credit Unions of North Carolina are emerging from a period of financial stringency unequaled in history. In spite of this they are generally reported in satisfactory condition.

R. O. Moen, who succeeded Fred R. Yoder as Specialist in Credit Unions, reports that at present there are twenty-nine credit unions incorporated in the State. They are located in fifteen counties in various parts of the State and are proving to meet the needs of the different types of farmers.

Most of the colored credit unions are operated in the cotton and tobacco growing sections where they take the form of coöperative purchasing societies. In following out the law their loans are made for productive purchases only. Any member wishing a loan fills out an application blank furnished by the secretary-treasurer, stating the amount of the loan and the length of time desired, the purpose for which the loan is to be used, and the kind of security offered. The purpose for which loans are made include the following: to help build barns and houses and fertilizers, livestock and farm machinery, seeds, food and feed supplies, and to pay off old debts incurred for productive purposes. The common interest rate charged is six per cent.

The credit unions organized among the white farmers take the form of coöperative banks. Deposits are always encouraged. They are added to the cash received from the sale of stocks to form a cash fund from which loans are made. Here, too, the secured loans are made for productive purposes to persons who can and will repay the loans at maturity. Banking accommodations are thus given to persons with surplus funds and savings as well as to the persons wishing short time loans who have not access to regular banking channels.

During the early part of the year the work of this office was directed toward expansion—five credit unions having been formed. Some attention was given to the improving of the accounting of the credit unions when the regular audits were made.

Since September first the work has been directed toward placing the weaker credit unions on a firmer financial and business basis. This is being accomplished by conducting analytical audits of the books and by directly helping the secretary-treasurers of the credit union.

Respectfully submitted,

B. F. Brown,

Chief, Division of Markets and Rural Organization,

State Superintendent of Warehouses.

REPORT ON FARM DRAINAGE

To the Director:—I hereby submit the annual report on drainage conducted under the coöperative agreement between the North Carolina Department of Agriculture and the United States Department of Agriculture. This report covers the crop year ending December 1, 1922.

Since May the division has had the services of J. A. Brophy, assistant drainage engineer, furnished by the U. S. Department as temporary assistant during June, July, August and September and taken over by the State Department on October 1.

The work has been conducted chiefly along the same lines as in previous years. In general our program consists (1) in assisting farmers to improve, by draining and terracing, those lands now under cultivation and (2) in making preliminary and reconnaisance examinations for drainage districts desiring to make drainage improvements.

Upon request, either from the county agent or the farmer, the drainage engineer makes preliminary examinations, surveys, designs, estimates, specifications, and report for tile drainage projects on the farm. A blueprint is sent to the farmer, showing the complete system of drains. When the farmer is ready to install the tile, certain drains are staked out in the field and instructions given in the proper methods of construction.

Terraces are laid off in entire fields, and instructions given in the use of the farm level and in terrace construction. The elementary principles of the use of the farm level in terrace location are taught at boys' club encampments. County agents in the counties needing terraces are instructed in the methods of terrace location and construction and the levels used in this work are tested and adjusted by the engineers of this office.

The engineer also makes preliminary examinations of drainage districts. The proposed district is visited and from all available data a report is prepared, accompanied by a map, copies of which are furnished to interested parties. The method of organizing a district under the State Drainage Law is outlined.

The following summary gives a fairly accurate idea of the amount of work done along these lines:

Farm Drainage

During the past twelve months, 44 farms situated in 22 counties have been visited for the purpose of giving assistance and advice in tile drainage. The area of these tracts covered by surveys and for which

plans and reports for tile drainage were proposed covered a total of 1,016 acres on 16 farms. This does not include areas examined, of which no survey was made or map prepared. Stakes and grades for tile drainage construction have been given on 13 farms in 9 counties for the installation of 88,265 feet of tile, approximating 17 miles. Twenty-two thousand feet of open ditch was staked out and grades and cuts given for construction.

Sixty-one farms in 17 counties have been visited for the purpose of giving assistance in the location and construction of terraces to prevent hillside erosion, the total length of terraces laid out being approximately 147,075 feet, or 28 miles.

Drainage Districts

Only one preliminary examination and report on a drainage district was made during the past year. This covered an area of 13,000 acres. The falling off in this branch of work was due partly to the large number of competent engineers in private practice that have located in the State and are carrying on this line of work efficiently, and to the smaller demand for land due to the readjustment of land values that has taken place during the past year. The engineers of the Division, however, were consulted by two districts for advice of a professional nature, and addressed several meetings of landowners on the State Drainage Law and methods of organization.

Miscellaneous

The results of experimental work and other general information have been published from time to time in the Extension Farm News and other papers, and publicity given in other ways. The Annual Convention of the North Carolina Drainage Association, held at Goldsboro, N. C., was attended and tile drainage and drainage district problems discussed. Attention was called by articles and discussion at the convention to the special benefits derived from tile drainage under boll weevil conditions. Assistance was given in a campaign held in Stanly County in farmstead improvement and landscape design on seven farms and four schools.

The past year has been notable for the interest taken and the amount of work accomplished in tile drainage, and stands as the high year's record of the Division. Terrace location was considerably lower than last year, when special effort was made to extend this form of improvement, but compares favorably with other years, being above that of November 1919-1920, the previous high record.

Respectfully submitted,

F. O. BARTEL,
Drainage Engineer.